

AD-A070 601

BAKER (MICHAEL) JR INC BEAVER PA

F/G 13/2

NATIONAL DAM INSPECTION PROGRAM. SAUL RUN DAM (NDI NUMBER PA-00--ETC(U)

DACW31-79-C-0011

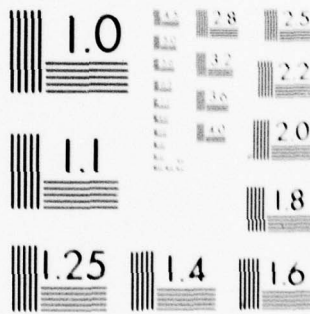
UNCLASSIFIED

NL

| OF |  
AD  
A070601



END  
DATE  
FILMED  
8-79  
DDC



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

AD A 070601

OHIO RIVER BASIN  
SAUL RUN, MERCER COUNTY  
PENNSYLVANIA

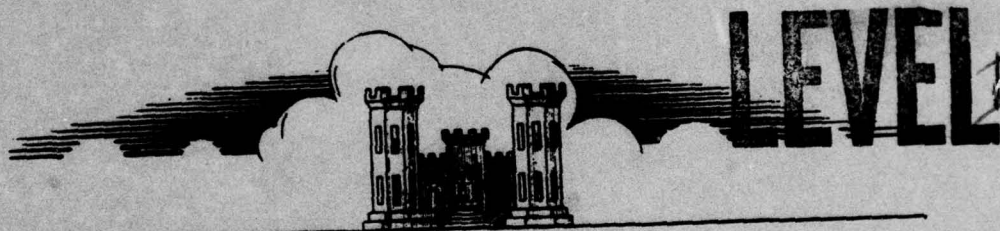
SAUL RUN DAM

NDI No. PA 00251  
PennDER No. 43-48

Distribution Unlimited  
Approved for Public Release  
Contract No. DACW31-79-C-0011

D'D C  
RECEIVED  
JUN 29 1979  
C

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers  
4301 Dutch Ridge Road  
Beaver, Pennsylvania 15009

April 1979

THIS DOCUMENT IS BEST QUALITY PRACTICABLE.  
COPY FURNISHED TO DDC CONTAINED A  
SIGNIFICANT NUMBER OF PAGES WHICH DO NOT  
REPRODUCE LEGIBLY.

ORIGINAL CONTAINS COLOR PLATES: ALL DDC  
REPRODUCTIONS WILL BE IN BLACK AND WHITE

79 06 28 082

OHIO RIVER BASIN

SAUL RUN DAM  
MERCER COUNTY, COMMONWEALTH OF PENNSYLVANIA  
NDI NO. PA 00251  
PennDER NO. 43-48

6 National Dam Inspection Program. Saul  
Run Dam (NDI Number PA-00251, PennDER  
Number 43-48), Ohio River Basin, Saul  
Run, Mercer County, Pennsylvania.  
Phase I Inspection Report.

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

13 DACTW 31-79-C-0011

Prepared for: DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203

Prepared by: MICHAEL BAKER, JR., INC.  
Consulting Engineers  
4301 Dutch Ridge Road  
Beaver, Pennsylvania 15009

Date:

11 Apr 21 1979

ORIGINAL CONTAINS COLOR PLATES: ALL DDC  
REPRODUCTIONS WILL BE IN BLACK AND WHITE

410 795

12 72 p.  
xlt



## **DISCLAIMER NOTICE**

**THIS DOCUMENT IS BEST QUALITY  
PRACTICABLE. THE COPY FURNISHED  
TO DDC CONTAINED A SIGNIFICANT  
NUMBER OF PAGES WHICH DO NOT  
REPRODUCE LEGIBLY.**

## PREFACE

This report was prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

Accession For	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
NTL G-2041	
DOC 123	
Unannounced	
Justification	
By	
Distribution	
Availability Codes	
Availand/or	
special	23042
Dist	A

PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

Saul Run Dam, Mercer County, Pennsylvania  
NDI NO. PA 00251, PennDER NO. 43-48  
Saul Run  
Date Inspected 7 December 1978

ASSESSMENT OF  
GENERAL CONDITIONS

Saul Run Dam is a homogeneous earth floodwater retarding dam designed by the U.S. Department of Agriculture, Soil Conservation Service. The dam has a crest length of 1700 feet, a maximum height of 40 feet, a storage volume of 200 acre-feet at spillway crest level, and a storage volume of 10 acre-feet at normal pool level.

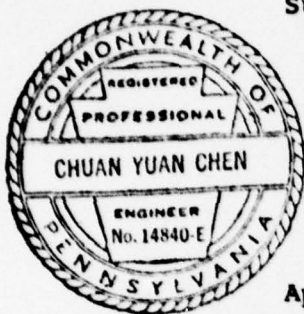
Visual inspection and review of engineering data in December 1978 indicated no serious deficiencies requiring emergency attention. The dam was found to be in very good overall condition at the time of inspection. Several relatively minor items of remedial work should be performed in the near future. These items are:

- 1) Cutting the few, small, scattered clumps of brush on the dam and in the spillway.
- 2) Repair of minor erosion areas on the dam.
- 3) Repair of three small erosion gullies at the downstream end of the spillway and installation of properly bedded riprap or other measures to prevent erosion from surface runoff in this area.
- 4) Improve the access to the dam.
- 5) Development of emergency evacuation and operations procedures.

The seepage and wet areas along the downstream toe of the dam, along the junctions of the downstream slope with both sides of the Saul Run channel, and along the channel sides downstream from the dam should be visually monitored in future dam inspections.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is therefore considered "adequate."

Submitted by:



MICHAEL BAKER, JR., INC.

*C. Y. Chen*  
C. Y. Chen, Ph.D., P.E.  
Engineering Manager-Geotechnical

Date: 5 April 1979

Approved by:

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT, CORPS OF ENGINEERS

*G. K. Withers*  
G. K. WITHERS  
Colonel, Corps of Engineers  
District Engineer  
Date:

22 Apr 79



SAUL RUN DAM



Overall View



## TABLE OF CONTENTS

	<u>Page</u>
Section 1 - Project Information	1
Section 2 - Engineering Data	6
Section 3 - Visual Inspection	8
Section 4 - Operational Procedures	10
Section 5 - Hydraulic and Hydrologic	12
Section 6 - Structural Stability	14
Section 7 - Assessment, Redommendations/Remedial Measures	15

## PLATES

Plate 1 - Location Plan	
Plate 2 - Watershed Map	
Plate 3 - Plan of Storage Areas (Drawing No. PA-458-P, Sheet 2 of 9, U.S. Department of Agriculture, Soil Conservation Service, February 1962; "As Built," 1963)	
Plate 4 - Plan of Damsite (Drawing No. PA-458-P, Sheet 3 of 9, U.S. Department of Agriculture, Soil Conservation Service, February 1962; "As Built," 1963)	
Plate 5 - Profiles of Dam and Emergency Spillway (Drawing No. PA-458-P, Sheet 4 of 9, U.S. Department of Agriculture, Soil Conservation Service, February 1962; "As Built," 1963)	
Plate 6 - Plan-Profile of Principal Spillway (Drawing No. PA-458-P, Sheet 6 of 9, U.S. Department of Agriculture, Soil Conservation Service, February 1962; "As Built," 1963)	

## APPENDICES

Appendix A - Check List - Visual Inspection and Field Sketch	
Appendix B - Check List - Engineering Data	
Appendix C - Photographs	
Appendix D - Hydrologic and Hydraulic Computations	
Appendix E - Regional Geology	

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM  
SAUL RUN DAM  
NDI NO. PA 00251  
PennDER NO. 43-48

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.
- b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances - Saul Run Dam, a flood water retarding dam designed by the U.S. Department of Agriculture, Soil Conservation Service (SCS), is also known by its SCS number PA-458. The homogeneous earth embankment has a crest length of approximately 1700 feet and a maximum height of about 40 feet. The dam crest at El. 1113.6 feet has a width of 16 feet. The upstream slope has an inclination of 3H:1V (horizontal:vertical) and an 8-foot wide berm at El. 1085 feet. The downstream slope with an inclination of 2.5H:1V also has an 8-foot wide berm at El. 1084 feet. A foundation cutoff trench with a base width of 12 feet, 1H:1V side slopes, a length of about 100 feet, and a depth of about 5 feet to bedrock was constructed in the valley bottom (Plate 5). Cutoff trenches of similar cross-section were also constructed in the soil abutments (Plate 5).

The outlet works (principal spillway in SCS terminology) consist of a reinforced concrete riser connected to a 24-inch diameter reinforced concrete pipe approximately 232 feet long. This outlet pipe is located beneath the embankment in the valley bottom (~~Plates 3-6~~). The outlet pipe, with six reinforced concrete anti-seep collars, was installed on a concrete cradle founded on bedrock.

(Plate 6). The downstream end of the outlet pipe (invert El. 1067.2 feet) protrudes from the embankment foundation and discharges into a small plunge pool excavated in bedrock (Plate 6).

The reinforced concrete riser unit is about 20 feet high. It has an overflow weir with trash rack and anti-vortex device at El. 1089 feet, and a low-level inlet consisting of a 1- by 2-foot orifice with invert El. 1086 feet (Plate 6). Normal pool level is controlled by this low-level inlet. At normal pool El. 1086 feet, the pond, which was designed to provide storage for 50 years of sediment accumulation, has a surface area of about 2 acres and a volume of about 10 acre-feet. A pond drain consisting of about 40 feet of 18-inch diameter bituminous coated corrugated metal pipe extends upstream from the riser unit (Plate 6). According to Mr. James Mondok of the Mercer County Conservation District, this pipe has a steel plate bolted on its inlet end.

The spillway (emergency spillway in SCS terminology) consists of a vegetated earth channel curving around the left (west) end of the dam (Plates 3 and 4). This channel has a centerline length of approximately 1200 feet, a base width of 100 feet, and 3H:1V side slopes. The control section of the spillway is at El. 1108 feet (Plate 4); this is some 5.6 feet below embankment crest level. The spillway crest level was selected to provide storage for runoff from a storm of a 100-year recurrence interval on the 1.0 square mile watershed. At spillway crest level (El. 1108 feet), the pond has a surface area of approximately 20 acres and a volume of about 200 acre-feet. The spillway discharges down the left (west) stream bank about 100 feet downstream from the dam (Plates 3 and 4). About 300 feet downstream from the dam, Saul Run flows through a 10-foot high by 7- to 8-foot wide stone arch culvert beneath a 40-foot high embankment of the Bessemer and Lake Erie Railroad (Plates 3 and 4).

The dam is located in an area of complex glacial soil deposits (Appendix E). Boring and test pit information obtained by the SCS, geologic information presented in the references listed in Appendix E, and field observations during dam inspection indicate that the dam foundation and abutments consist of glacial till, moraine and/or kame-type soil deposits overlying relatively shallow bedrock.



The dam was constructed of well-graded, granular, and relatively impervious glacial soils obtained from the spillway excavation and borrow areas in the reservoir (Plates 3 and 5).

- b. Location - Saul Run Dam is located on Saul Run about 0.5 mile east of Greenville in Hempfield Township, Mercer County, Pennsylvania (Plate 1). The dam is about 400 feet east of the Bessemer and Lake Erie Railroad (Plates 1-4). Access to the dam is via the railroad right-of-way or trails across woodland and farmland. The nearest highway is PA Route 58 which extends northwesterly from Mercer to Greenville and lies about 1 mile southwest of the dam (Plate 1). The portion of this highway in Greenville is known as Mercer Street.
- c. Size Classification - The maximum height of the dam is 40 feet and the reservoir volume to the top of dam (El. 1113.6 feet) is approximately 321 acre-feet. The dam is therefore in the "Intermediate" size category.
- d. Hazard Classification - In the event of failure of Saul Run Dam, it is likely that "more than a few" lives would be lost and economic losses would be "excessive." The dam is therefore considered to be in the "high" hazard category.
- e. Ownership - The dam is owned by the Mercer County Commissioners, Mercer County Courthouse, Mercer, Pennsylvania 16137.
- f. Purpose of Dam - The dam is used for floodwater detention.
- g. Design and Construction History - Saul Run Dam was designed by the SCS under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. The dam was constructed by Kane Brothers Company of Youngstown, Ohio, from September 1962 through August 1963. No work was done over the winter from December 1962 until sometime in the Spring of 1963.
- h. Normal Operational Procedures - The pond is typically maintained at the low-level inlet of the riser structure, El. 1086+ feet. There has reportedly been no major flood since the dam was constructed,

and it seems unlikely that the pond has ever reached the level of the spillway inlet, El. 1108+ feet (Plates 3, 4, and 5). Operational information is scanty as the dam is in a somewhat remote location, has no operating equipment, and is only occasionally visited by Mercer County or SCS personnel. Mercer County and SCS personnel inspect the dam each year according to procedures for annual inspection of SCS dams of this type. Copies of annual inspection reports are available in the Mercer office of the SCS and in the files of the Pennsylvania Department of Environmental Resources (PennDER). Routine maintenance of the dam and spillway is performed as necessary by Mercer County personnel.

### 1.3 PERTINENT DATA

- a. Drainage Area - The drainage area of Saul Run Dam is 620 acres or 1.0 square miles.
- b. Discharge at Dam Site - The maximum discharge at the dam site is not available.
- c. Elevation [feet above Mean Sea Level (M.S.L.)] -
 

Top of Dam -	1113.6
Maximum Pool -	1111.1
Normal Pool -	1086
Streambed at Centerline of Dam -	1073
Maximum Tailwater -	N.A.
- d. Reservoir (feet) -
 

Length of Maximum Pool -	1800
Length of Normal Pool -	600
- e. Storage (acre-feet) -
 

Top of Dam (El. 1113.6 ft.) -	321
Maximum Pool (El. 1111.1 ft.) -	257
Spillway Crest (El. 1108.0 ft.) -	200
Normal Pool (El. 1086.0 ft.) -	10
- f. Reservoir Surface (acres) -
 

Spillway Crest (El. 1108 ft.) -	20
Normal Pool (El. 1086 ft.) -	2



g. Dam -

Type - Homogeneous earth embankment  
Length (feet) - 1700  
Maximum Height (feet) - 40  
Crest Width (feet) - 16  
Side Slopes - Upstream - 3H:1V  
                    Downstream - 2.5H:1V  
Cutoff - Compacted earth cutoff with 12-foot base  
                    width in foundation and abutments.

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type - Vegetated earth channel curving around left  
                    (west) end of dam.  
Length (feet) - 1200  
Base Width (feet) - 100  
Side Slopes - 3H:1V  
Crest Elevation (feet) 1108  
Gates - None  
Downstream Channel - Stream channel approximately  
                            100 feet wide extends 300 feet  
                            downstream to 10-foot high by  
                            7- to 8-foot wide stone arch  
                            culvert beneath 40-foot high  
                            railroad embankment.

j. Regulating Outlets - Reinforced concrete riser  
structure connected to 24-inch diameter reinforced  
concrete pipe beneath the dam has overflow weir at  
El. 1089 feet and low level orifice inlet at El. 1086  
feet. The downstream end of the outlet pipe has  
invert El. 1067 feet.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

Saul Run Dam was designed by the SCS according to its standard practice for structures of this type, circa 1960. Design data included in this report were obtained from:

- 1) SCS Drawings No. PA-458-P, "Saul-Mathay Watershed Project, Floodwater Retarding Dam PA-458, Mercer County, Pennsylvania," February 1962. (Prints of 9 sheets of design drawings are available in PennDER files. Prints of 1963 "as built" drawings are available in files of the SCS Harrisburg office. Copies of Sheets 2, 3, 4, and 6 of the "as built" drawings are included in this report as Plates 3-6.)
- 2) SCS Drawings No. PA-458-H, "Saul-Mathay Watershed Project, Floodwater Retarding Dam PA-458, Mercer County, Pennsylvania," December 1961, 2 sheets of Hydrograph Drawings. (Prints are available in PennDER files.)
- 3) "Saul-Mathay Watershed Work Plan," report prepared by Mercer County Commissioners, et al., March 1960 (copy in file of Mercer office of SCS).
- 4) Dam Permit Application Report prepared by the Pennsylvania Department of Forests and Waters (predecessor of PennDER) on 31 May 1962.
- 5) Design information (including boring and test pit logs, laboratory soil data, and design calculations in the files of the SCS Harrisburg office).

### 2.2 CONSTRUCTION

Readily available information on the construction of Saul Run Dam was summarized in paragraph 1.2.g. This information was obtained from the files of PennDER and the Mercer office of the SCS. Additional construction information may exist in retired files of the S.C.S. Such additional information, if it does exist, is not readily available and it was not reviewed in connection with this Phase I Inspection Report.

The livestock water supply line shown on Sheets 2 and 3 of the SCS drawings (Plates 3 and 4 of this report) was never installed. This was verified in an interview with Mr. Richard Crowley, SCS Mercer Area Conservationist, on 8 December 1978.

### 2.3 OPERATION

Readily available information on operation of Saul Run Dam was summarized in paragraph 1.2.h. Most of this information was obtained from interviews with Mr. James Mondok of the Mercer County Conservation District on 6-8 December 1978.

### 2.4 EVALUATION

The above-referenced readily available information is considered adequate for purposes of this Phase I Inspection Report on Saul Run Dam.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

- a. General - The dam and its appurtenances were found to be in very good overall condition at the time of inspection. Most of the problems noted during the visual inspection are considered minor and do not require immediate remedial treatment. Noteworthy items are described briefly in the following paragraphs. The complete visual inspection check list is included in Appendix A along with a field sketch of the dam.
- b. Dam - A few scattered small clumps of brush were noted on the dam slopes. This brush should be cut during routine maintenance.

Minor erosion was observed at several locations including apparent motorcycle trails on the dam crest and slopes and along the junctions of the downstream slope with both abutments in the Saul Run channel. These erosion areas should be repaired during routine maintenance in 1979 and efforts to prevent the use of motorcycles and other vehicles on the dam should be increased.

Seepage estimated at about 1 g.p.m. was noted about 8 feet above tailwater (about 5 feet above dam toe) at the junctions of the downstream slope with both abutments in the Saul Run channel. No evidence of piping (internal erosion of fine soil particles) was observed at these locations.

Minor to moderate seepage on the order of a few g.p.m. was also noted along both sides of the Saul Run channel for distances of 80 to 100 feet downstream from the toe of the dam. Maximum heights of seepage were about 8 and 12 feet above tailwater on the right (east) and left (west) sides of the channel, respectively. No evidence of piping was observed at these locations. Soft, wet, swampy areas exist along both stream banks beneath these areas of seepage from the downstream channel sides.

A slightly soft, wet area about 50 feet long and 5 feet high was observed on the left (west) side of the downstream slope above the berm at El. 1084+ feet. A similar, slightly soft, wet area about 3 feet high was observed along the downstream toe



of the dam. No noticeable seepage could be found in these soft, wet areas. Rain which fell intermittently during the inspection made seepage investigations in these areas extremely difficult.

Seepage along the junctions of the downstream slope with both abutments and along both downstream channel slopes is attributed to natural groundwater flow at or near the contact between glacial soils (till and/or moraine) and underlying bedrock (shaly sandstone). The soft, wet areas along both sides of the downstream channel result from this natural groundwater flow. The soft, wet areas along the downstream toe of the dam and above the berm on the left side of the downstream slope probably result largely from natural groundwater flow. It is possible, however, that seepage from the pond may be contributing to the wetness of these areas, especially along the downstream toe of the dam. The seepage areas and soft, wet areas observed during the field inspection are not considered detrimental to stability of the dam. These areas should be visually monitored, however, during future dam inspections.

- c. Appurtenant Structures - A few scattered small clumps of brush were noted in the spillway. This brush should be cut during routine maintenance in 1979.

Minor seepage was observed at several locations along the toes of excavation slopes and dike slopes on both sides of the spillway. This seepage, which is well above normal pond level, is attributed to natural groundwater flow and is not considered detrimental to spillway stability or operation.

Three small erosion gullies (the largest about 20 feet long with maximum width and depth of about 3 feet) were noted at the center of the downstream end of the spillway where surface runoff flows down the natural slope to Saul Run. These erosion gullies should be repaired during routine maintenance in 1979. Properly bedded riprap or other measures should be installed in this area to prevent erosion from surface runoff.

- d. Downstream Channel - An uninhabited reach of Saul Run extends approximately 300 feet downstream from the dam to a 10-foot high by 7- to 8-foot wide stone-masonry arch culvert beneath a 40-foot high embankment of the Bessemer and Lake Erie Railroad. The east edge of the Borough of Greenville (1970 population 8700 persons) is located about 0.5 mile downstream from the culvert.



## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

Operational procedures are summarized in paragraph 1.2.h.

There are no formal emergency procedures in the event of impending catastrophe for the dam. It is understood that the condition of the dam is checked by Mercer County personnel following each occurrence of heavy precipitation. The spillway and outlet works are uncontrolled and the pond drain pipe reportedly has a steel plate bolted on its inlet (paragraph 1.2.a.). Rapid emergency drainage of the pond is therefore impossible. According to the PennDER Dam Permit Application Report, the time required to lower the pond from the crest of the emergency spillway (El. 1108 feet) to the crest of the riser unit (El. 1089 feet) is 38.2 hours. With water level at the riser orifice (El. 1086 feet), the pond storage volume is on the order of 10 acre-feet. Additional emergency drawdown capability is never likely to be required. One possible method of draining the pond completely is pumping the water into the riser orifice.

It is recommended that a formal emergency procedure be prepared and prominently displayed, and furnished to all personnel. This should include:

- 1) Procedures for evaluating inflow during periods of emergency operation.
- 2) Procedures for rapid drawdown of the reservoir under emergency conditions.
- 3) Who to notify in case evacuation from the downstream area is necessary.

In addition, the owner should develop an emergency evacuation plan for areas which will be affected in the event of a dam failure.

### 4.2 MAINTENANCE OF DAM AND APPURTENANCES

Routine maintenance is performed periodically by Mercer County personnel as noted in paragraph 1.2.h.

### 4.3 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of a dam failure. An emergency warning procedure should be developed.

#### 4.4 EVALUATION OF OPERATIONAL ADEQUACY

The nature of Saul Run Dam and its appurtenances are such that the present operational and maintenance procedures are adequate.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

- a. Design Data - Hydrologic and hydraulic design data for Saul Run Dam were obtained from SCS's and PennDER's files.

Criteria developed by the SCS and used in the design of Saul Run Dam are as follows:

- 1) The elevation of the normal pool (low stage orifice invert) is determined by the volume of the 50-year sediment deposit.
- 2) The 100-year storm runoff volume (200 acre-feet), based on 4.2 inches of rainfall runoff, is used to determine the crest of the emergency spillway.
- 3) The emergency spillway hydrograph, based on a 6-hour point rainfall of 9.2 inches resulting in a peak discharge of 2480 c.f.s., is routed through the reservoir to determine the design high water elevation.
- 4) The freeboard hydrograph is then routed through the reservoir to determine the elevation of the dam crest. The freeboard hydrograph is based on a 6-hour point rainfall of 19.2 inches which results in a peak discharge of about 4730 c.f.s.

- b. Experience Data - Prior to the construction of the Saul Run Dam, flooding from Saul Run occurred on a rather frequent basis. According to Mercer County Conservation District representative Mr. James Mondok, however, since construction of the dam; the reservoir water level has never reached the high stage riser inlet. No detailed reservoir stage or rainfall records were available.

- c. Visual Observations - There is a 10-foot high stone arch culvert located approximately 300 feet downstream from Saul Run Dam. This culvert carries Saul Run beneath the Bessemer and Lake Erie Railroad embankment. Although backwater effects from this culvert could significantly reduce discharges from the riser outlets, discharges from the emergency

spillway would not be affected because of the elevation difference between the emergency spillway crest and the railroad culvert. It can therefore be concluded that the overall performance of the outlet works would be relatively unaffected during a flood of magnitude equal to the Probable Maximum Flood (PMF).

- d. Overtopping Potential - Saul Run Dam is classified as a "High" hazard-"Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the PMF. The outlet works consist of a typical SCS concrete riser and a well vegetated side-channel spillway. The hydrologic and hydraulic capabilities of the reservoir, outlet works, and spillway were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The PMF hydrograph developed as part of this analysis had a peak discharge of 1377 c.f.s. based on a peak 6-hour rainfall of 21.6 inches. The results of the flood routing indicate that the reservoir and spillway are capable of passing the PMF with a corresponding reservoir level of El. 1110.9 feet. This maximum reservoir stage is 2.7 feet below the minimum top of dam El. 1113.6 feet.
- e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing the PMF without overtopping. Therefore, the spillway is classified as "adequate" according to the recommended criteria.

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed from coefficients determined by the Baltimore District, U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed, however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.



## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - No structural inadequacies were noted during visual inspection of the dam.
- b. Design and Construction Data - The dam was designed and constructed according to standard SCS procedures for structures of this type. Information in the files of the SCS Harrisburg office indicates that the upstream slope has a minimum safety factor of 1.82 for rapid drawdown conditions and the downstream slope has a minimum safety factor of 1.66 for steady seepage conditions. These computed safety factors are of course adequate.

General experience with slopes of heights, inclinations, materials, and hydraulic conditions similar to those of the dam slopes indicates that these slopes could be shown to satisfy the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." This inference is supported by SCS experience and by empirical guidelines given by the U.S. Bureau of Reclamation (1973) Design of Small Dams, 2nd edition, pp. 261-267. In view of the modest height and inclinations of the dam slopes, their history of satisfactory performance, and the fact that no indications of instability were observed during the field inspection of 7 December 1978, no further stability assessments are necessary for this Phase I Inspection Report.

- c. Operating Records - Nothing in the readily available operating information indicates cause for concern relative to structural stability of the dam.
- d. Post-Construction Changes - No changes which would affect structural stability of the dam have been made since construction was completed.
- e. Seismic Stability - The dam is located in Zone 1 on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is an area of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. For the reasons outlined in paragraph 6.1.b., no further considerations of structural stability are necessary in this report.



## SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

- a. Safety - Visual inspection on 7 December 1978 indicated the dam to be in a safe condition at that time.

The spillway capacity was analyzed using criteria presented in the "Recommended Guidelines for Safety Inspection of Dams" and according to procedures presented in paragraph 5.1.d. This analysis indicates that the spillway is adequate to pass the PMF without overtopping the dam.

- b. Adequacy of Information - The readily available information and the observations made during field inspection of the dam are considered sufficient for purposes of this Phase I Inspection Report.
- c. Urgency - No urgent remedial work is required.
- d. Necessity for Additional Data/Evaluation - No further investigation is necessary.

### 7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed a few items of remedial work which should be performed by the owner during routine maintenance in 1979. These include:

- 1) Cutting the few small scattered clumps of brush on the dam and in the spillway.
- 2) Repair of minor erosion areas on the dam. Efforts to prevent use of motorcycles and other vehicles on the dam and in the spillway should be increased.
- 3) Repair of three small erosion gullies at the downstream end of the spillway and installation of properly bedded riprap or other measures to prevent erosion from surface runoff in this area.
- 4) Improve the access to the dam.

Emergency evacuation and operations procedures should be developed by the owner, including:

- a) Procedures for evaluating inflow during periods of emergency operation.
- b) Procedures for rapid drawdown of the reservoir under emergency conditions.
- c) Development of an emergency evacuation plan, including who to notify, for areas which will be inundated in the event of a flood or dam failure.

Seepage and wet areas along the downstream toe of the dam, along the junctions of the downstream slope with both sides of the Saul Run channel, and along the channel sides downstream from the dam should be visually monitored in future dam inspections.

PLATES





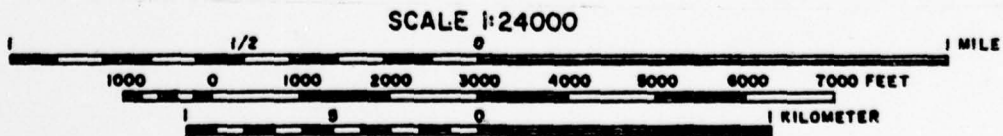
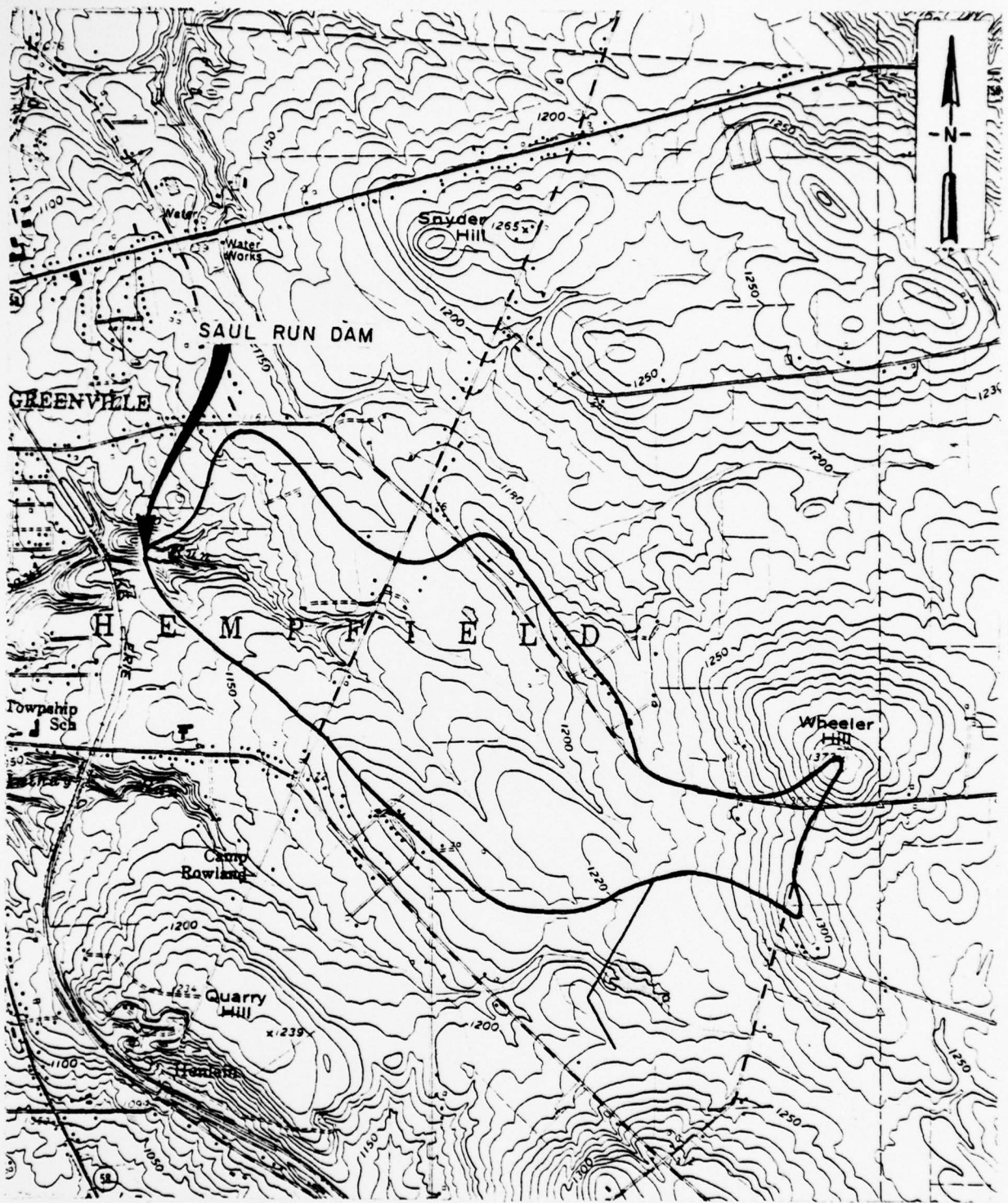
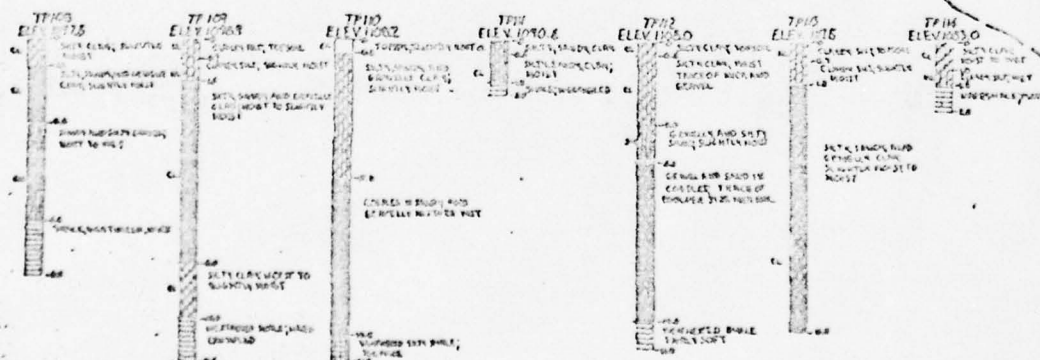
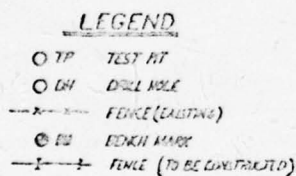
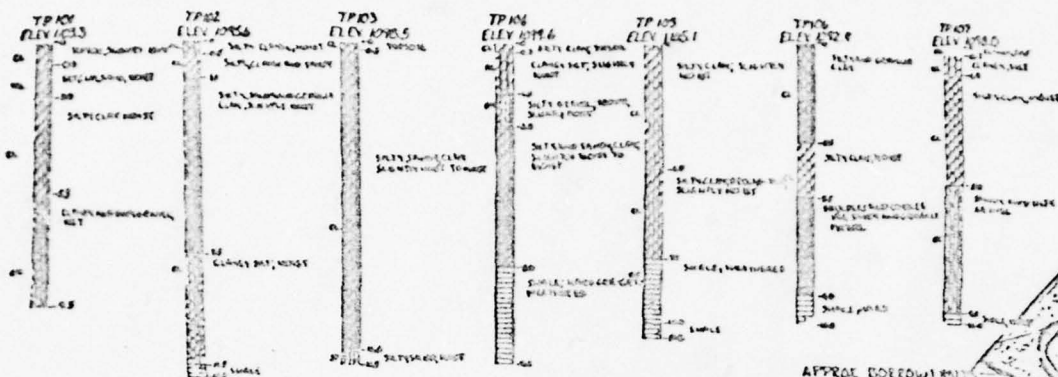


PLATE 2 WATERSHED MAP  
SAUL RUN DAM



**NOTE:**

1. ENTIRE MINIMAL POOL AREA TO BE CLEARED.  
SEE P. 2-1
2. EXPOSED AREAS, LONG DIAGONAL AREAS, AREAS  
ACROSS THE DAM AND EXPOSED AREAS AT DAM  
ARE TO BE CLEARED AND GRASSED.  
SEE P. 2-1
3. ALL FILL TO BE COMPACTED GALL'ING.  
SEE P. 2-1

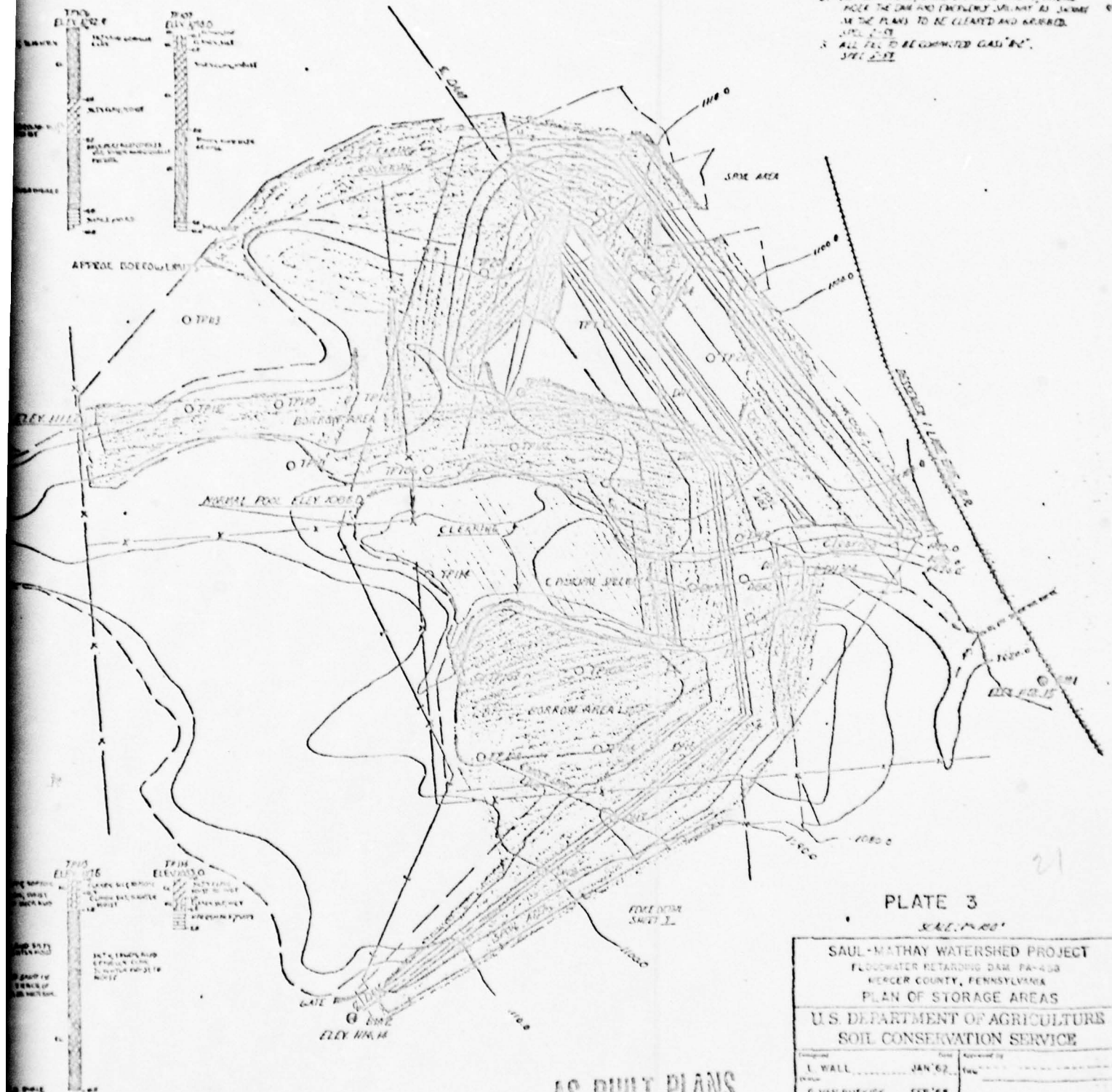


PLATE 3

S.A.E. 10-60

SAUL-MATHAY WATERSHED PROJECT  
FLOODWATER RETAINING DAM, PA-458  
MERCER COUNTY, PENNSYLVANIA  
PLAN OF STORAGE AREAS  
U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed by	Drawn by	Checked by	Approved by
I. WALL	JAN '62		
G. VAN BUSKIRK	FEB '62		
G. CARPENTER	FEB '62		
			PA-458-P

AS BUILT PLANS  
Approx. Half Scale

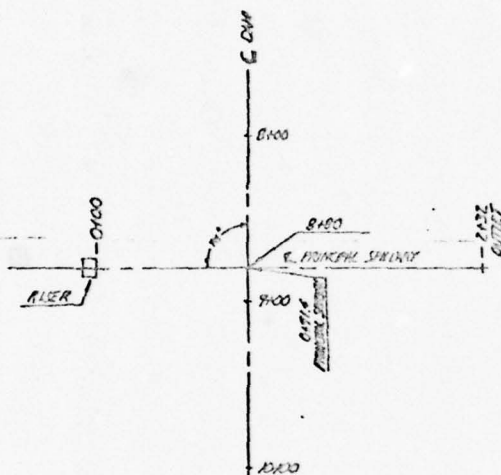
1 1 2



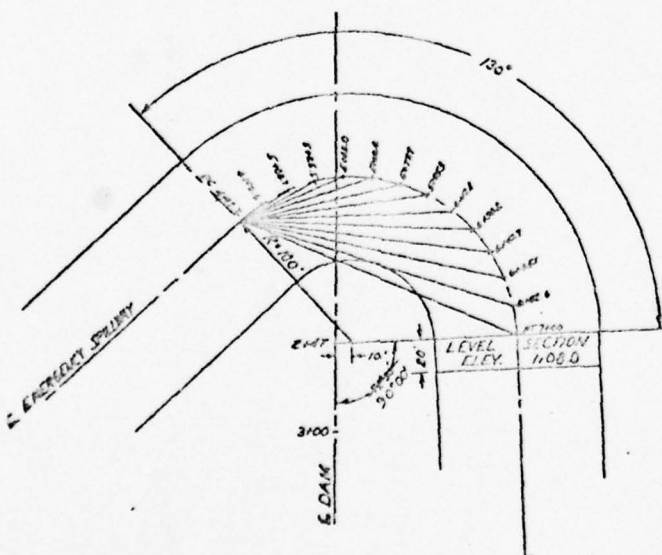
REF #1 - TOP SUR CORNER OF OLD FOUNDATION - 20.74'  
REF #2 - NW CORNER OF OLD FOUNDATION - 10.27'  
REF #3 - NAIL IN W. CHERRY SPLINES - 18.9'

LOADED AT SEA 1945  
E DWD (EXTENDED)

REF 1245  
LOCATION OF REFERENCE POINTS



LAYOUT OF PRINCIPAL SPILLWAY  
SCALE 1" = 50'



LAYOUT OF EMERGENCY SPILLWAY  
SCALE 1"=50'

CURVE DATA

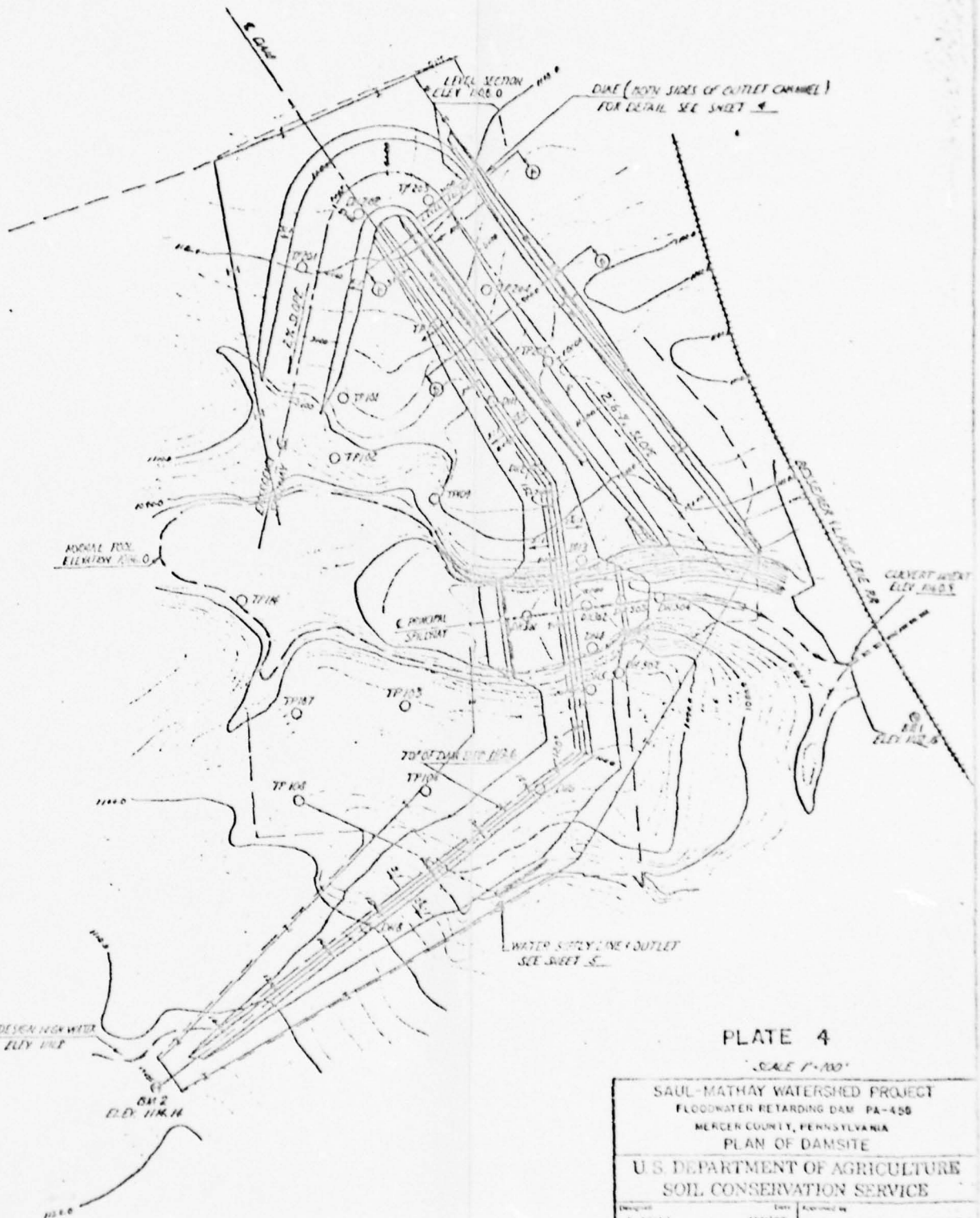
$R = 100'$   
 $A = 130'$   
 $L = 226.68'$   
 $C = 181.26'$   
 $T = 214.45'$

STATION	DEFL. %	CHORD
FC-4132	0°-00'	0
4130.6	5°-00'	17.45'
5108.1	10°-00'	17.45'
5125.5	15°-00'	17.45'
5143.0	20°-00'	17.45'
5160.4	25°-00'	17.45'
5177.9	30°-00'	17.45'
5195.3	35°-00'	17.45'
6112.8	40°-00'	17.45'
6130.2	45°-00'	17.45'
6147.7	50°-00'	17.45'
6165.1	55°-00'	17.45'
6182.6	60°-00'	17.45'
7100	65°-00'	17.42'

DE SCHAUN HUGH WRIGHT  
ELEV 11118

DM 2  
ELEV. 11K 14





**CURVE DATA**

R=100'      M=57.74  
 A=130'      E=137  
 L=221.22'    PC=4175.2  
 C=181.26'    PT=7100  
 T=214.65'

STATION	DEFL. X	CHORD
4173.2	0°-00'	0
4190.6	5°-00'	17.45'
5108.1	10°-00'	17.45'
5125.5	15°-00'	17.45'
5143.0	20°-00'	17.45'
5160.4	25°-00'	17.45'
5177.9	30°-00'	17.45'
5195.3	35°-00'	17.45'
6112.8	40°-00'	17.45'
6130.2	45°-00'	17.45'
6147.7	50°-00'	17.45'
6165.1	55°-00'	17.45'
6182.6	60°-00'	17.45'
7100	65°-00'	17.42'

**PLATE 4**

SCALE 1"=100'

SAUL-MATHAY WATERSHED PROJECT  
 FLOODWATER RETARDING DAM PA-458  
 MERCER COUNTY, PENNSYLVANIA  
 PLAN OF DAMSITE  
 U.S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE

Designed by L. VELL	Date JAN '62	Reviewed by [ ]
Drawn by G. VAN BUSKIRK	Date FEB '62	Reviewed by [ ]
Checked by D. CARPENTER	Date FEB '62	Reviewed by [ ]
Drawing No. PA-458-P		Sheet 3 of 6

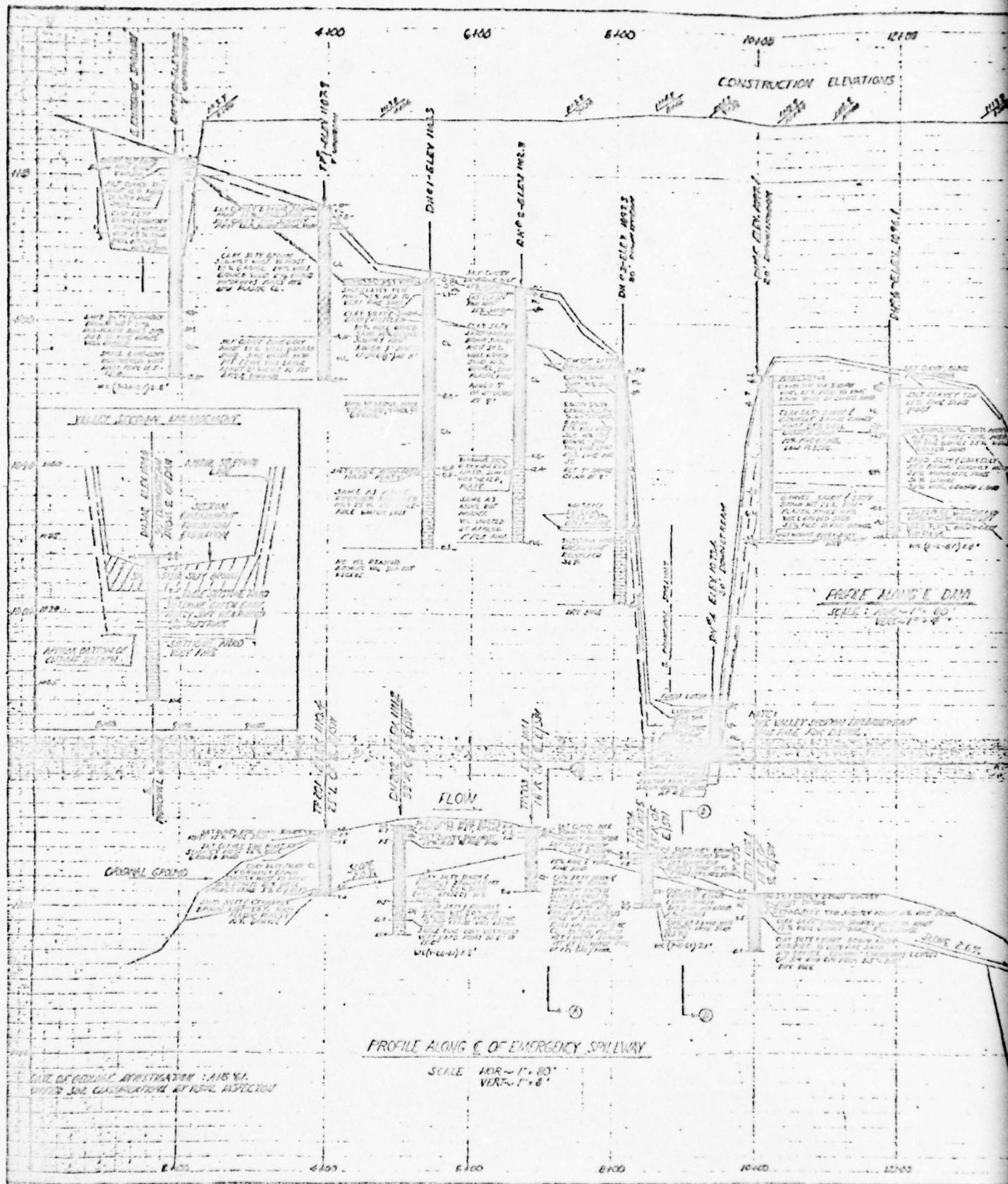
**AS BUILT PLANS**

Approx. Half Scale

1

1

2



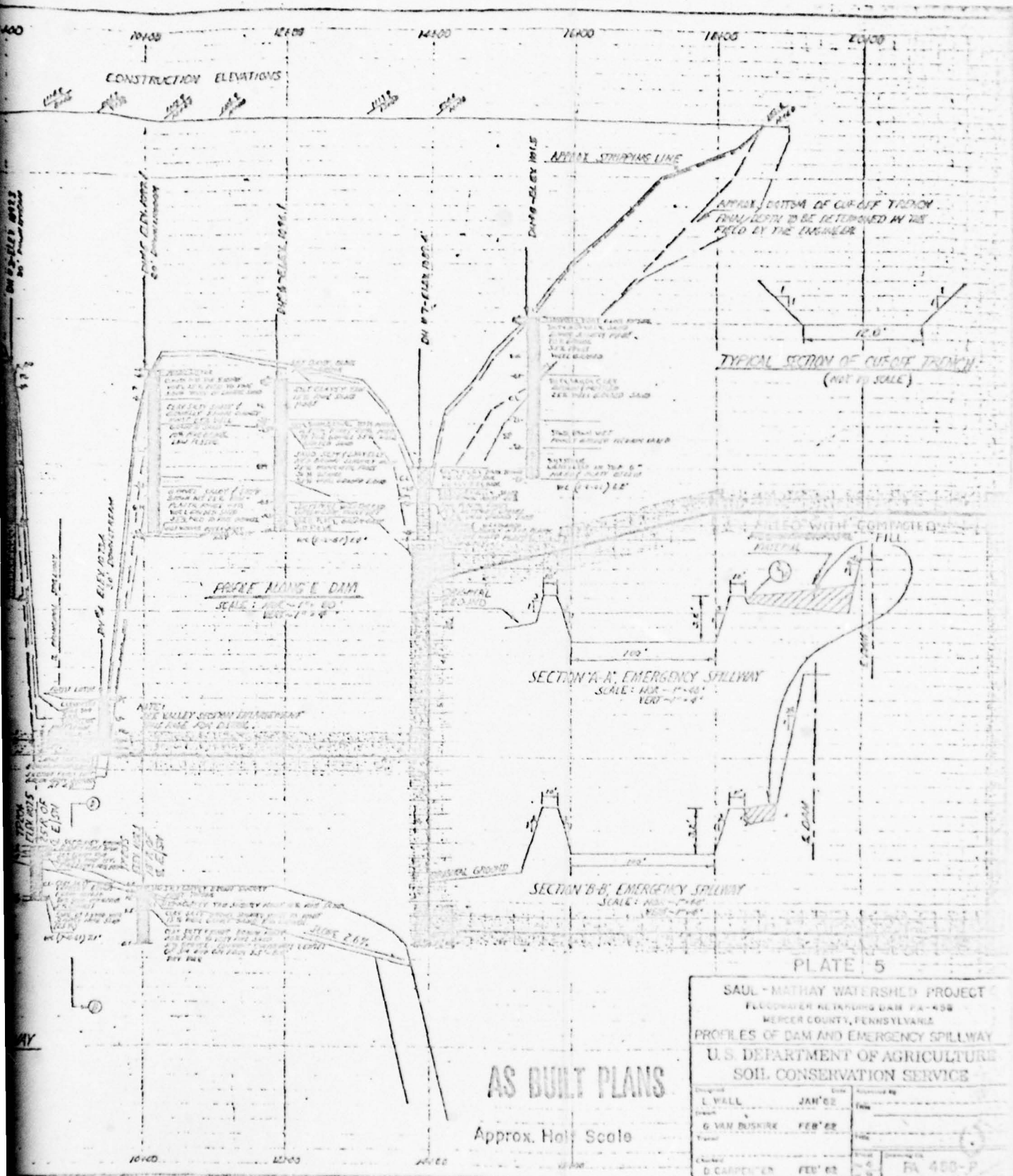


PLATE 5

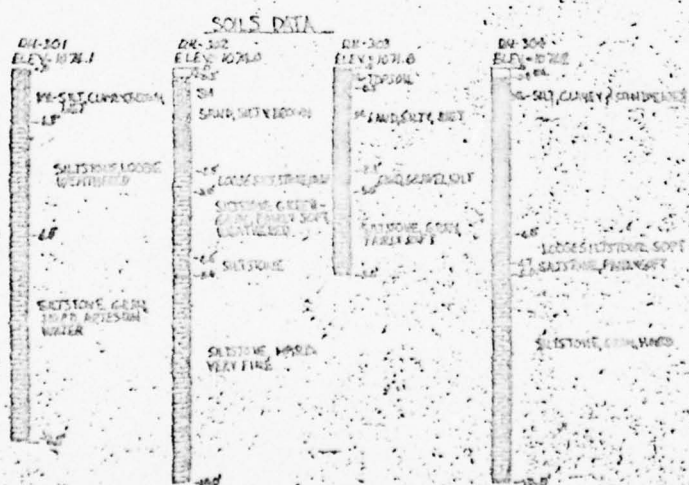
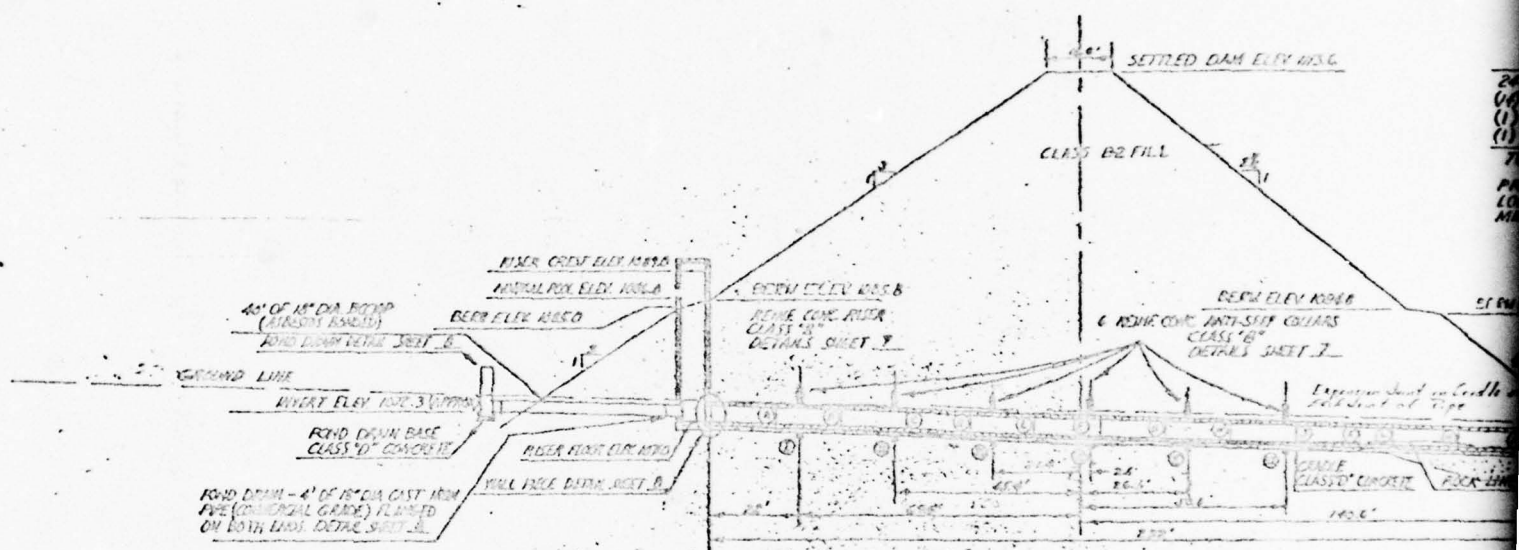
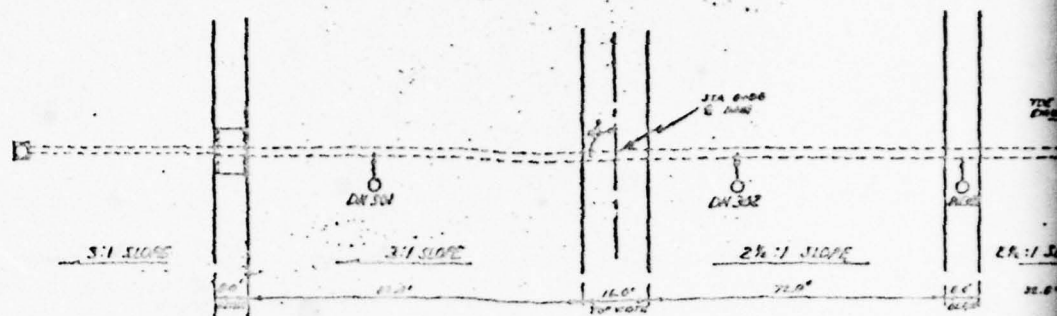
SAUL-MATHRAY WATERSHED PROJECT			
FLOODWATER RETARDING DAM, PA-458			
MERCER COUNTY, PENNSYLVANIA			
PROFILES OF DAM AND EMERGENCY SPILLWAY			
U.S. DEPARTMENT OF AGRICULTURE			
SOIL CONSERVATION SERVICE			
Designed by	L. WALL	Date	JAN '62
Drawn by	G. VAN BUSKIRK	Date	FEB '62
Checked by	D. CARPENTER	Date	FEB '62
			PA 458-P

AS BUILT PLANS

Approx. Half Scale

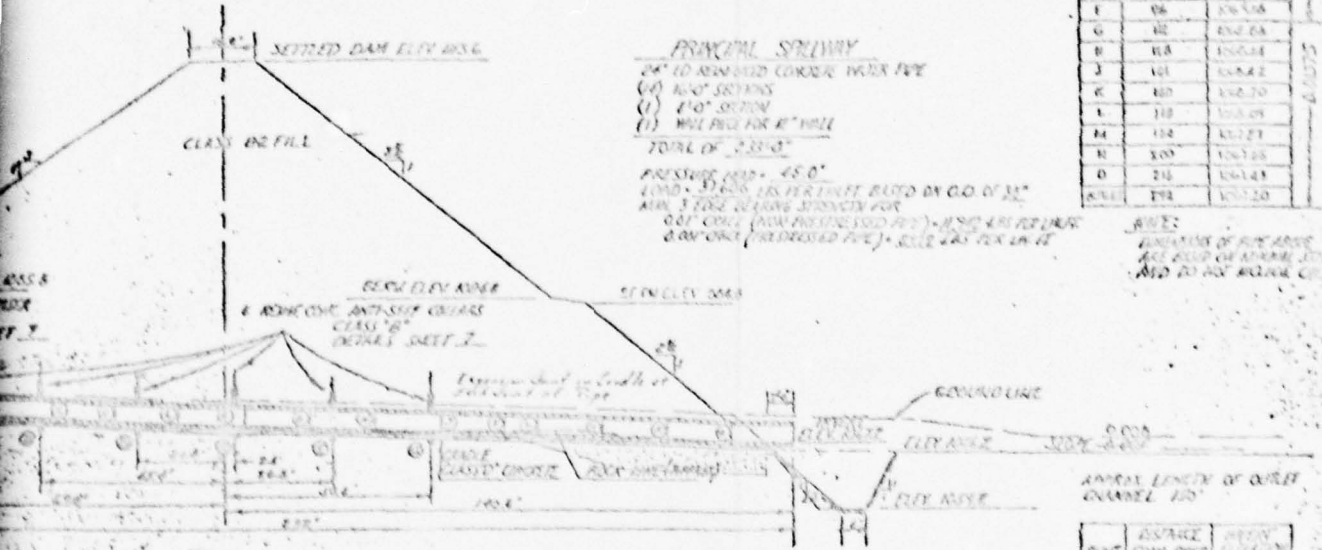
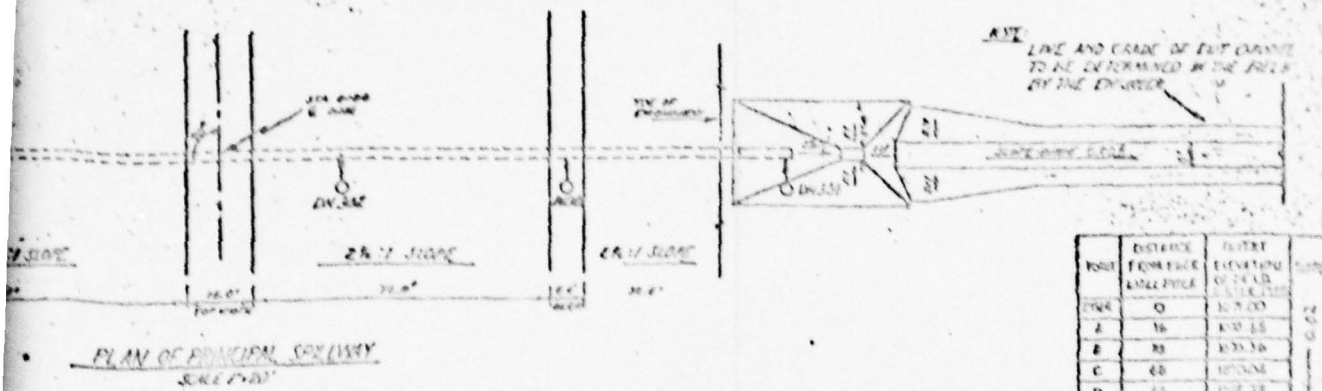
1 2





DATE OF GEOLOGIC INVESTIGATION - AUG 61.  
UNITED SOL. CLASSIFICATIONS BY VISUAL INSPECTION.





POST	DISTANCE FROM PLACE LAST PRICE	PERCENT INCREASE OF 24 HRS. PREVIOUS
Q	0	100.00
Z	16	100.15
B	32	100.36
C	48	100.66
D	64	100.72
B	80	100.80
F	96	100.90
G	112	100.98
B	128	100.98
J	144	100.82
C	160	100.70
E	176	100.69
M	192	100.29
H	208	100.28
N	224	100.13
Q	240	100.10

DATE	DISTANCE FROM ROCK FACE	DEPTH IN FEET
I	22"	10.30.55
II	28"	10.30.40
III	30"	10.30.45
IV	34"	10.30.45
V	118"	10.31.20
VI	162"	10.31.55



AS BUILT PLANS

Approx. Half Scale

PLATE 6	
SAUL-MATHAY WATERSHED PROJECT	
FLOODWATER RETARDING DAM PA-458	
MERCEER COUNTY, PENNSYLVANIA	
PLAN-PROFILE OF PRINCIPAL SPILLWAY	
U.S. DEPARTMENT OF AGRICULTURE	
SOIL CONSERVATION SERVICE	
Drawing Scale	Horizontal By
1" = 100'	JAN '62
Vertical	1" = 10'
By G. VAN BUREN	FEB '62
Checked by	PA-458-P

APPENDIX A

CHECK LIST - VISUAL INSPECTION  
AND FIELD SKETCH

Check List  
Visual Inspection  
Phase 1

Name of Dam Saul Run County Mercer State PA Coordinates Lat. N 41°24.1'  
 NDI # PA 00251 Long. W 80°21.6'  
 PennDER # 43-48

Date Inspection 7 Dec. 1978 Weather Cloudy & Damp Temperature 40°-45°F.  
 (Intermittent rain, sometimes heavy, from 10 AM to 1 PM)

Pool Elevation at Time of Inspection 1086.4 ft. M.S.L. Tailwater at Time of Inspection 1067.4 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ullinski  
 Rodney E. Holderbaum  
 James V. Hamel

Owner's Representatives  
Mercer County Conservation District:

James Mondok (part-time)

James V. Hamel Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: SAUL RUN  
NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		



CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: SAUL RUN  
NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

## EMBANKMENT

Name of Dam: SAUL RUN  
 NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None were observed.	The embankment is well vegetated with grasses. The few small clumps of brush and berry bushes on the embankment slopes should be cut during routine maintenance.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None were observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing was observed. Minor erosion was observed at several motorcycle trails and paths on the upstream and downstream embankment slopes. Minor erosion was also observed at both junctions of the downstream slopes with the abutments at the Saul Run channel.	Minor erosion should be repaired during routine maintenance. Efforts to prevent motorcycle and off-road vehicle traffic on dam and in spillway should be increased.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No problems were observed.	
RIPRAP FAILURES	There is no riprap.	

## EMBANKMENT

Name of Dam: SAUL RUN  
 NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	<p>There are minor (widths and depths less than 2 ft.) erosion gullies along the junctions of the downstream slopes with both abutments at Saul Run.</p> <p>Seepage estimated at about 1 g.p.m. was observed about 8 ft. above tailwater at the junctions of the downstream slope with both abutments at Saul Run.</p>	<p>These minor erosion gullies should be repaired during periodic maintenance.</p> <p>This seepage is considered natural spring flow at base of glacial till.</p>
ANY NOTICEABLE SEEPAGE	<p>Seepage was observed along the lower parts of both channel slopes for 80-100 ft. downstream from toe of dam to maximum heights above tailwater of about 8 ft. on the right side and about 12 ft. on the left side.</p> <p>A slightly soft and wet area about 50 ft. long and 5 ft. high was observed on the left side of the downstream slope above the berm (El. 1084± ft.). A slightly soft and wet zone about 3 ft. high was observed along the downstream toe of the dam in the Saul Run channel.</p>	<p>This seepage is considered to be natural groundwater flow exiting in springs at or below the till-rock contact.</p> <p>No noticeable seepage could be found in these slightly soft, wet areas. They should be checked in future dam inspections.</p>
STAFF GAGE AND RECORDER	There is no staff gage or recorder.	
DRAINS	There are no drains.	

## OUTLET WORKS

Name of Dam: SAUL RUN  
NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Most of the outlet conduit was inaccessible. The condition of the conduit, at its outlet, appeared to be very good.	
INTAKE STRUCTURE	The intake structure is in good condition. No cracking or spalling of the concrete was noted. Minor debris is located on the trash rack of the low stage inlet.	Debris should be removed during routine maintenance.
OUTLET STRUCTURE	There is no outlet structure. The 24-in. diameter reinforced concrete outlet pipe discharges directly into the plunge pool described below.	
OUTLET CHANNEL	A plunge pool about 25 ft. wide by 50 ft. long extends downstream from the 24-in. diameter outlet pipe. This plunge pool was excavated to a maximum depth of about 6 ft. in shaly sandstone bedrock. Further downstream, the outlet channel is about 6 ft. wide and well paved with flaggy, cobble to small boulder size fragments of sandy shale.	The plunge pool and outlet channel are adequate for normal flows. Damage from flood flows, if any, can be repaired after the floods.
EMERGENCY GATE	Pond drain line (18-in. diameter bituminous coated corrugated metal pipe extending 40 ft. upstream from drop-inlet) is reportedly closed off with a steel plate bolted to the flange of cast-iron end section.	Pond cannot readily be drained below normal pool drop-inlet opening (invert El. 1086 ft.).



## UNGATED SPILLWAY

Name of Dam: SAUL RUN  
 NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	There is no concrete weir. The spillway is a well vegetated earth channel which was excavated in dense, well graded, essentially impervious glacial till. The bedrock surface is about 6 ft. below the base of spillway.	The spillway channel and its side slopes are stable from soil mechanics and hydraulics (erosion) standpoints.
APPROACH CHANNEL	Seepage (natural groundwater flow discharging in springs) occurs along toes of excavated slopes on both sides of the spillway approach channel and discharge channel.	Two small clumps of brush in approach channel should be cut during routine maintenance. Seepage (spring flow) presents no problems.
DISCHARGE CHANNEL	There are three small erosion gullies at center of downstream end of discharge channel where surface runoff flows down natural slope to Saul Run. The largest gully has a maximum width and depth of about 3 ft. and a length of about 20 ft. The other two gullies are smaller.	The three erosion gullies should be repaired and properly bedded riprap or other measures should be installed in this area to prevent erosion from surface runoff.

## BRIDGE AND PIERS

There are no bridges or piers.

**GATED SPILLWAY - Not Applicable**

Name of Dam: SAUL RUN

NDI # PA 00251

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

CONCRETE BILL

APPROACH CHANNEL

DISCHARGE CHANNEL

BRIDGE AND PIERS

GATES AND OPERATION  
EQUIPMENT

INSTRUMENTATION - There is no instrumentation.

Name of Dam: SAUL RUN  
NDI # PA 00251

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
--------------------	--------------	----------------------------

MONUMENTATION/SURVEYS

OBSERVATION WELLS

WEIRS

PIEZOMETERS

OTHER

## RESERVOIR

Name of Dam: \_\_\_\_\_  
 NDI # PA 00251

SAUL RUN

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are flat in the borrow areas on both sides of the pond and moderately steep in glacial soil deposits upstream from the pond. The slopes are in dense, well graded glacial tills, moraines, and other ice contact deposits with good vegetative cover.	The reservoir slopes are stable from soil mechanics and hydraulics (erosion) standpoints.

## SEDIMENTATION

Minor sedimentation was observed all around the edges of the 2 acre pond upstream from the dam. This pond acts essentially as a sediment and debris basin.

Sedimentation is relatively insignificant here due to watershed characteristics. The pond was designed by the SCS with allowance for 50 years of sediment accumulation.



## DOWNSTREAM CHANNEL

Name of Dam: SAUL RUN  
NDI # PA 00251

VISUAL EXAMINATION OF		OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is relatively free of debris and obstructions. The overbank areas are primarily wooded. There is a 10-ft. high by 7 to 8 ft. wide stone-masonry, arch railroad culvert approximately 300 ft. downstream from the dam. This culvert could cause a serious obstruction to flow if it were blocked with debris. The top of the railroad embankment is approximately 40 ft. above the culvert invert.		
	SLOPES	Left bank slope has glacial till over weathered sandy shale-shaly sandstone bedrock. Right bank slope is glacial moraine or ice contact ridge (probably a kame-type deposit). The gorge-like channel was probably cut by glacial meltwater and runoff.	Downstream channel slopes to railroad embankment arch culvert are stable from soil mechanics and hydraulics (erosion) standpoints.

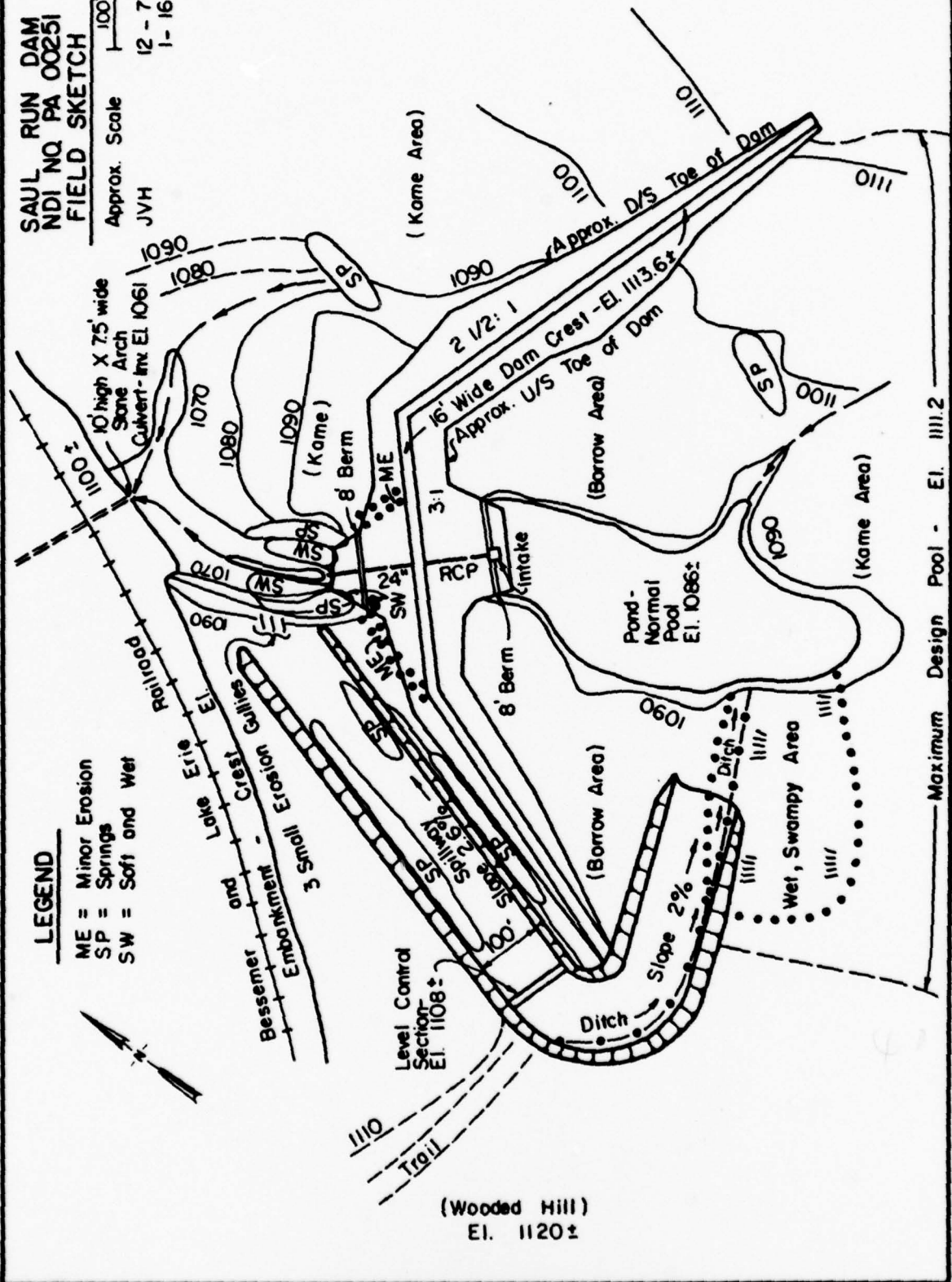
APPROXIMATE NO. The Borough of Greenville is located approximately  
OF HOMES AND 0.5 mile downstream from the dam. Greenville has a  
POPULATION population of about 8700 persons (1970 census).

SAUL RUN DAM  
NDI NO PA 00251  
FIELD SKETCH

Approx. Scale 1" = 100'  
12-7-78  
1-16-79  
JVH

LEGEND

- ME = Minor Erosion
- SP = Springs
- SW = Soft and Wet



Maximum Design Pool - El. 1111.2

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: SAUL RUN  
NDI # PA 00251

ITEM	REMARKS
PLAN OF DAM	Reference Drawings: "Saul-Mathay Watershed Project, Floodwater Retarding Dam PA-458, Mercer County, Pennsylvania," U.S. Department of Agriculture, Soil Conservation Service (SCS), February 1962 (9 sheets of 1963 "As Built" drawings available in files of SCS Harrisburg office; prints of 1962 design drawings available in PennDER files). Plan of Dam - Reference Drawings Sheets 2 and 3, included in this report as Plates 3 and 4.
REGIONAL VICINITY MAP	Reference Drawings - Sheet 1: Section of U.S.G.S. Greenville East, Pennsylvania, 7.5 minute quadrangle in this report as Plate 1.
CONSTRUCTION HISTORY	Information in files of PennDER and in files of Mercer office of SCS indicates the dam was constructed by Kane Brothers Company of Youngstown, Ohio from September 1962 to August 1963. No work was done over the winter from December 1962 until sometime in the Spring of 1963.
TYPICAL SECTIONS OF DAM	Reference Drawings - Sheets 4 and 6 (included as Plates 5 and 6 of this report).
HYDROLOGIC/HYDRAULIC DATA	Some hydrologic/hydraulic data are included in the "Saul-Mathay Watershed Work Plan" report prepared by the Mercer County Commissioners, et. al., March 1960. Other information is included in the Dam Permit Application Report prepared by the Pennsylvania Department of Forests and Waters (PDFW) on 31 May 1962. This report is in PennDER files. Prints of SCS drawings "Freeboard Hydrograph" and "Emergency Spillway Hydrograph," December 1961, are also in PennDER files. Additional hydrologic/hydraulic data are available in files of SCS Harrisburg office.
OUTLETS	PLAN Reference Drawings - Sheets 2, 3, 6, 7, and 8. (Sheets 2, 3, and 6 are included in this report as Plates 3, 4, and 6).
	- DETAILS Reference Drawings - Sheets 6, 7, and 8.
	- CONSTRAINTS No information is readily available.
	- DISCHARGE RATINGS No information is readily available.
RAINFALL/RESERVOIR RECORDS	None are readily available.



Name of Dam: SAUL RUN  
 NDI # PA 00251

ITEM	REMARKS
DESIGN REPORTS	No complete design report is readily available, but design report components are available in files of SCS Harrisburg office. Additional design information is included in the "Saul-Mathay Watershed Work Plan" and in the PennDER Dam Permit Application Report.
GEOLOGY REPORTS	No geology report is readily available. Some geology information is included in the "Saul-Mathay Watershed Work Plan," PennDER's Permit Report and files of the SCS Harrisburg office.
DESIGN COMPUTATIONS	Design computations on these subjects are available in the files of the SCS Harrisburg
HYDROLOGY & HYDRAULICS	office.
DAM STABILITY	
SEEPAGE STUDIES	
MATERIALS INVESTIGATIONS	Boring and test pit locations and logs are shown on Sheets 2, 3, 4, and 6 of the
BORING RECORDS	Reference Drawings (included as Plates 3-6 of this report). Additional information
LABORATORY	exists in the files of the SCS Harrisburg office.
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	Annual inspections have been made from 1965 to 1978 by representatives of the Mercer County Commissioners and the SCS. Copies of all inspection reports are available in the Mercer office of the SCS. Copies of most inspection reports are available in PennDER files.
BORROW SOURCES	Glacial soil deposits in the spillway and the reservoir areas: Plan - Reference Drawings - Sheet 2 (included as Plate 3 of this report). Boring and Test Pit Logs - Reference Drawings - Sheets 2 and 4 (included as Plates 3 and 5 of this report). Additional information on borrow sources is available in the files of the SCS Harrisburg office.

Name of Dam: SAUL RUN  
 NDI # PA 00251

ITEM	REMARKS
------	---------

MONITORING SYSTEMS	There are no monitoring systems.
--------------------	----------------------------------

**MODIFICATIONS** A fence was constructed around the outlet pipe plunge pool in 1965 or 1966. No other modifications appear to have been made.

**HIGH POOL RECORDS** No information is readily available.

**POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS** Annual inspections have been made from 1965 to 1978 by representatives of the Mercer County Commissioners and the SCS. Copies of all inspection reports are available in the Mercer office of the SCS. Copies of most inspection reports are available in PennDER files.

**PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS** There have been no accidents or failures.

**MAINTENANCE OPERATION RECORDS** No maintenance or operations records are readily available.

B-1

Name of Dam: SAUL RUN  
NDI # PA 00251

ITEM	REMARKS
SPIILLWAY PLAN	Reference Drawings - Sheets 2 and 3 (included as Plates 3 and 4 of this report).
SECTIONS	Reference Drawings - Sheet 4 (included as Plate 5 of this report).
DETAILS	Reference Drawings - Sheets 2, 3, and 4 (included as Plates 3-5 of this report).

OPERATING EQUIPMENT      There is no operating equipment.  
PLANS & DETAILS

CHECK LIST  
HYDROLOGIC AND HYDRAULIC DATA  
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.1 sq. mi. of well vegetated, moderately rolling hills covered with glacial soil deposits

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1086.0 ft. (10 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1108.0 ft. (200 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: 1111.2 ft. (257 ac.-ft.)

ELEVATION TOP DAM: 1113.6 ft. (321 ac.-ft.)

SPILLWAY: \_\_\_\_\_

- a. Elevation 1108.0 ft. (control section, emergency spillway)
- b. Type Vegetated earth channel, curved in plan
- c. Width 100 ft.
- d. Length 1200 ft. (along centerline)
- e. Location Spillover Left abutment
- f. Number and Type of Gates There are no gates.

OUTLET WORKS: \_\_\_\_\_

- a. Type Reinforced concrete riser and 24-in. diameter reinforced concrete outlet pipe
- b. Location Base of embankment at center of valley
- c. Entrance inverts El. 1086.0 ft. (low level), El. 1089.0 ft. (high level)
- d. Exit inverts El. 1067.2 ft.
- e. Emergency drawdown facilities None (steel plate bolted on end of pond drainpipe entrance invert El. 1072± ft.)

HYDROMETEOROLOGICAL GAGES: None

- a. Type \_\_\_\_\_
- b. Location \_\_\_\_\_
- c. Records \_\_\_\_\_

MAXIMUM NON-DAMAGING DISCHARGE Not available



APPENDIX C

PHOTOGRAPHS

## DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam - View Northeast at Upstream Side of Dam  
from Left (West) Abutment Area

[Pond in right-center of photo; intake structure near center of photo (left end of pond); spillway entrance below pond; spillway curves around left end of dam in bottom and left side of photo.]

Photo 1 - View West over Pond, Intake Structure, and Upstream Slope of Dam at Spillway Entrance (Top Left-Center of Photo) from Dam Crest

Photo 2 - View Upstream (South) over Pond from Dam Crest (Intake structure in bottom left corner of photo.)

Photo 3 - Close-up View East at Intake Structure [Right (east) side of dam extends across top of photo.]

Photo 4 - View Upstream (South) over Plunge Pool at Downstream Slope of Dam (R. E. Holderbaum on 24-inch diameter reinforced concrete outlet pipe in center of photo; J. V. Hamel on dam crest in top right corner of photo.)

Photo 5 - View Downstream (North) over Outlet Pipe and Plunge Pool from Dam Crest [Soft, wet swampy areas resulting from natural groundwater flow on both sides of plunge pool; stone arch culvert under railroad embankment (Photos 6 and 7) is behind trees in top right corner of photo.]

Photo 6 - View Downstream (Northwest) at Entrance of Ten-foot High Stone Arch Culvert under Bessemer and Lake Erie Railroad Embankment (Culvert is approximately 300 feet downstream from dam; embankment height is approximately 40 feet.)

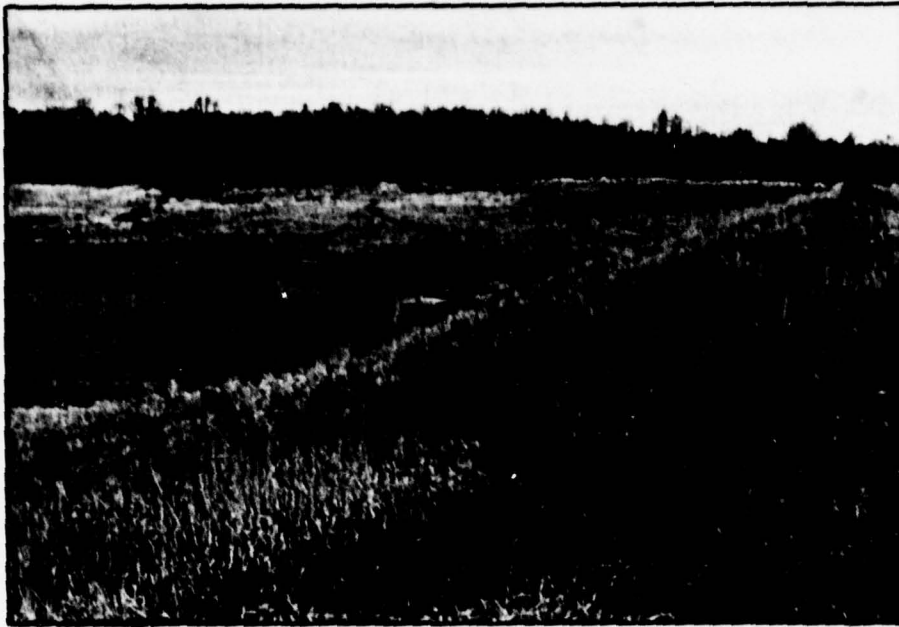
Photo 7 - Close-up of Stone Arch Culvert beneath Railroad Embankment (Photo 6)

Note: Photographs were taken on 7 December 1978.

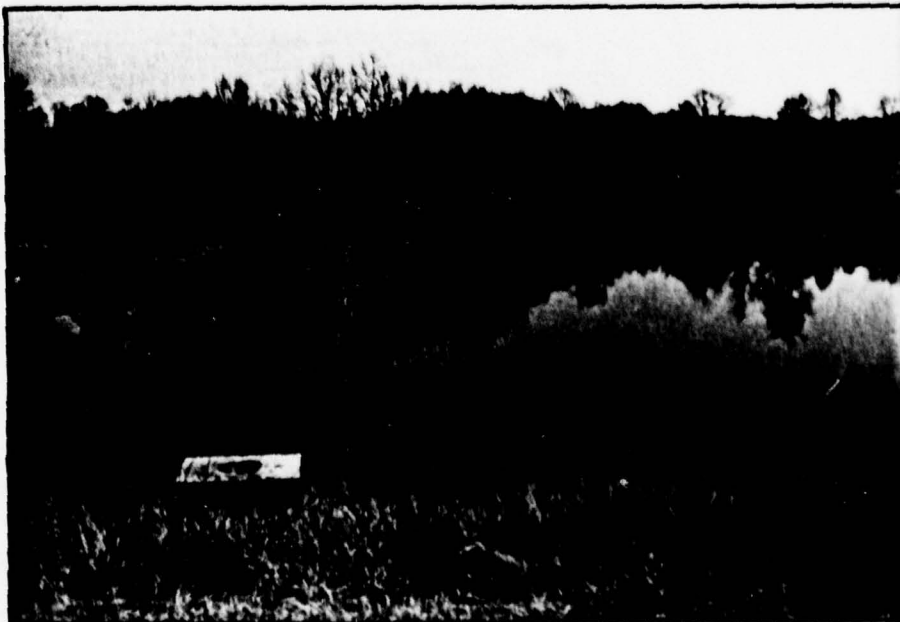
- Photo 8 - View Downstream (East) at Spillway Outlet from Top of Excavated Slope on Left (Northwest) Side of Spillway  
[Downstream slope of dam in top right-center of photo; three small erosion gullies (close-up of largest in Photo 11) are located between R. E. Holderbaum and J. V. Hamel in left-center of photo.]
- Photo 9 - View West over Downstream Slope of Dam and Outlet Pipe at Left (West) Abutment Seepage Area Attributed to Natural Groundwater Flow  
[Spillway outlet behind trees in top right portion of photo; seepage line extends from R. E. Holderbaum (left-center of photo) to J. V. Hamel (right-center of photo); spillway outlet erosion gullies (Photos 8 and 11) are above J. V. Hamel in top right corner of photo.]
- Photo 10 - View East from Dam Crest over Downstream Slope and Outlet Pipe at Right Abutment Seepage Area Attributed to Natural Groundwater Flow  
[Seepage line extends from R. E. Holderbaum (right-center of photo) to J. V. Hamel (left-center of photo).]
- Photo 11 - Close-up View East of J. V. Hamel in Largest of Three Erosion Gullies in Spillway Outlet (Center of Photo 8)  
[Gully is about 20 feet long by 3 feet maximum width and depth in glacial till or moraine.]

Note: Photographs were taken on 7 December 1978.

**SAUL RUN DAM**



**PHOTO 1. View West at Spillway Entrance**



**PHOTO 2. View Upstream over Pond**



## SAUL RUN DAM

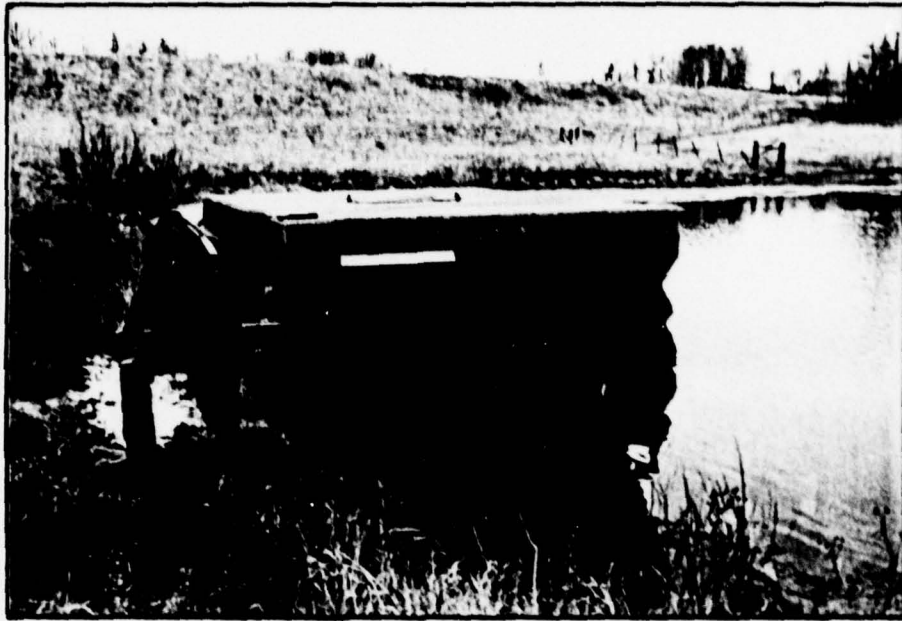


PHOTO 3. Close-up of Intake Structure

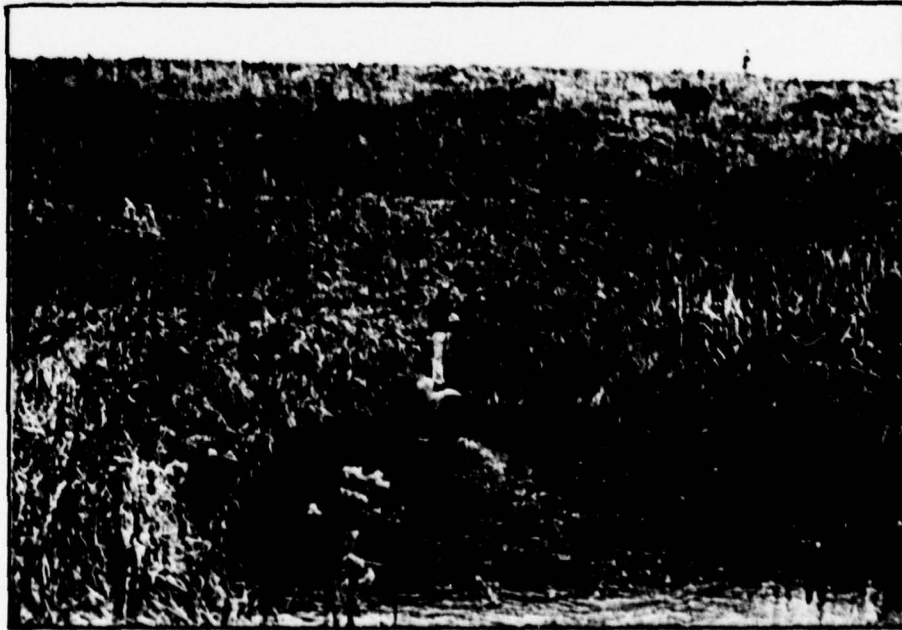


PHOTO 4. Downstream Slope and Outlet Pipe

# **SAUL RUN DAM**

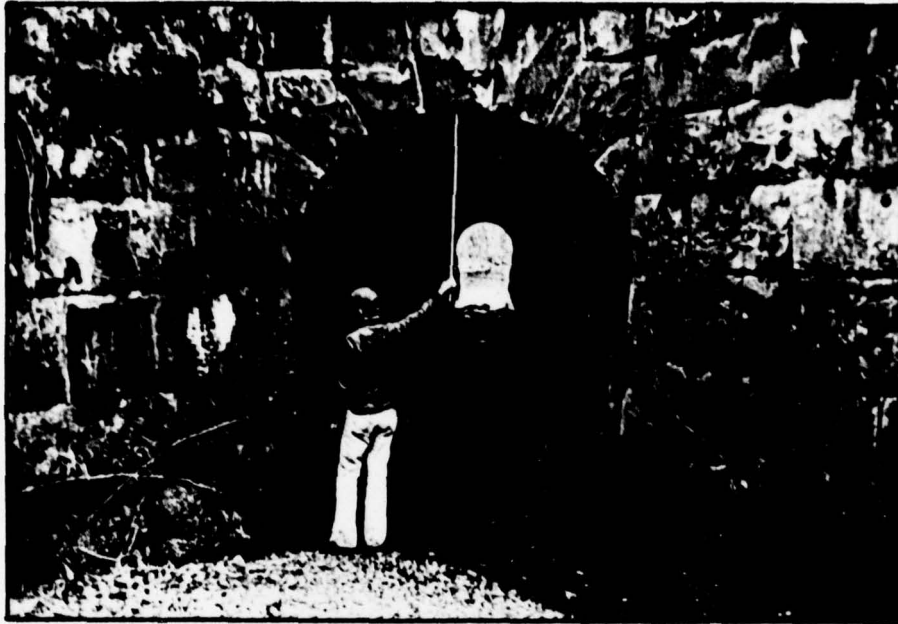


**PHOTO 5. View Downstream over Plunge Pool**



**PHOTO 6. Stone Arch Culvert beneath Railroad**

**SAUL RUN DAM**



**PHOTO 7. Close-up of Railroad Culvert**



**PHOTO 8. View East at Spillway Outlet**

**SAUL RUN DAM**



**PHOTO 9. View West at Downstream Left Abutment**



**PHOTO 10. View East at Downstream Right Abutment**



**SAUL RUN DAM**



**PHOTO 11. Close-up of Largest Spillway Outlet Erosion Gully**

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS

MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Saul Run Dam

S.O. No. \_\_\_\_\_

Sheet No. \_\_\_\_\_ of \_\_\_\_\_

Drawing No. \_\_\_\_\_

Computed by \_\_\_\_\_

Checked by \_\_\_\_\_

Date \_\_\_\_\_

### Table of Contents

<u>Subject</u>	<u>Page</u>
Rainfall & Hydrograph Data	1
Watershed Map	2
Stage - Storage - Discharge	3
Top of Dam Data	4
Map of Lake and downstream damage area	5
Computer Analysis	6-10



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Soul Run Dam S.O. No. \_\_\_\_\_  
Rainfall Hydrograph Data Sheet No. 1 of 10  
Drawing No. \_\_\_\_\_  
Computed by P.A.S. Checked by REH Date 2-27-79

### Rainfall Data

From HMR-33 D.A. is less than 10 sq. mi.  
located in Zone 2.

$$PM P_{2hr} = 2.00 \text{ in.} = 23.1 \text{ in.}$$

$$P_{6hr} = 117\%$$

$$P_{12hr} = 127\%$$

$$P_{24hr} = 141\%$$

$$P_{48hr} = 151\%$$

### Hydrograph

DA is located in Zone 2T

$$L_p = 5.45$$

$$t_p = 2.7(L - L_{ca})^{0.3}$$

$$t_p = 2.7(L - L_{ca})^{0.3}$$

$$= 2.7(2.31 - 1.02)^{0.3}$$

$$DA = 9.766 \text{ sq. mi.}$$

$$= 3.49 \text{ hr}$$

$$L = 2.31 \text{ mi.}$$

$$t_r = t_p / 5.5$$

$$L_{ca} = 1.02 \text{ mi.}$$

$$= 3.49 / 5.5$$

$$t_r = 20 \text{ min.}$$

$$= 0.63$$

$$t_{rp} = t_p + 0.25(t_r - t_r)$$

$$= 3.49 + 0.25(0.63 - 0.63)$$

$$= 3.41 \text{ hrs}$$



sheet 2 of 10

Saul  
Run  
Dam



centroid

Quad: Greenville East  
Drainage Area: 0.966 mi.<sup>2</sup>  
L: 2.31 mi. Lca: 1.02 mi.

SCALE: 1" = 2000'  
DATE: 3-28-79

Saul Run Dam Watershed

MICHAEL BAKER JR. INC.  
Consulting Engineers & Surveyors

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009Subject Saul Run Dam

S.O. No. \_\_\_\_\_

Stage vs. Storage &amp; Discharge

Sheet No. 3 of 10

Drawing No. \_\_\_\_\_

Computed by G.G.S. Checked by REH Date 2-20-79

(feet)	(Ac.-Ft.)	(c.f.s.)
<u>Stage</u>	<u>Storage</u>	<u>Discharge</u>
1086	0	0
1088	3.5	25
1090	12	32
1095	30	37
1100	65	40
1105	127.5	42
1107	147	44
1108	197.5	45
1109	209	375
1110	232.5	750
1111	256.2	1425
1112	281	2250
1113	305	3250
1114	330	4400

top of dam design = 1113.6 msl  
 storage = 321 Ac-ft.  
 discharge = 4700 cfs.

Note: The above information was taken from  
 the Freeboard Hydrograph Design Dwg.  
 No. PA-458-H

MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Saul Run Dam

Top of Dam & Dyke Profile

S.O. No. \_\_\_\_\_

Sheet No. 4 of 10

Drawing No. \_\_\_\_\_

Computed by REN Checked by \_\_\_\_\_

Date 3-6-79

Average Top of Dam Elev = 1114.0 ft.  
Design Top of Dam Elev = 1113.6 ft.

Overtopping data:

$L = 1640$  feet

$C = 2.65$

$c = 1.5$

$Q = CLH^{3/2}$

Emergency Spillway

Horizontal dist (feet)

Elev.  
(ft.)

1115

1110

1105

1100

900

600

300

0

300

600

900



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Soul Run Dam

S.O. No. \_\_\_\_\_

Dam Location and downstream  
damage area

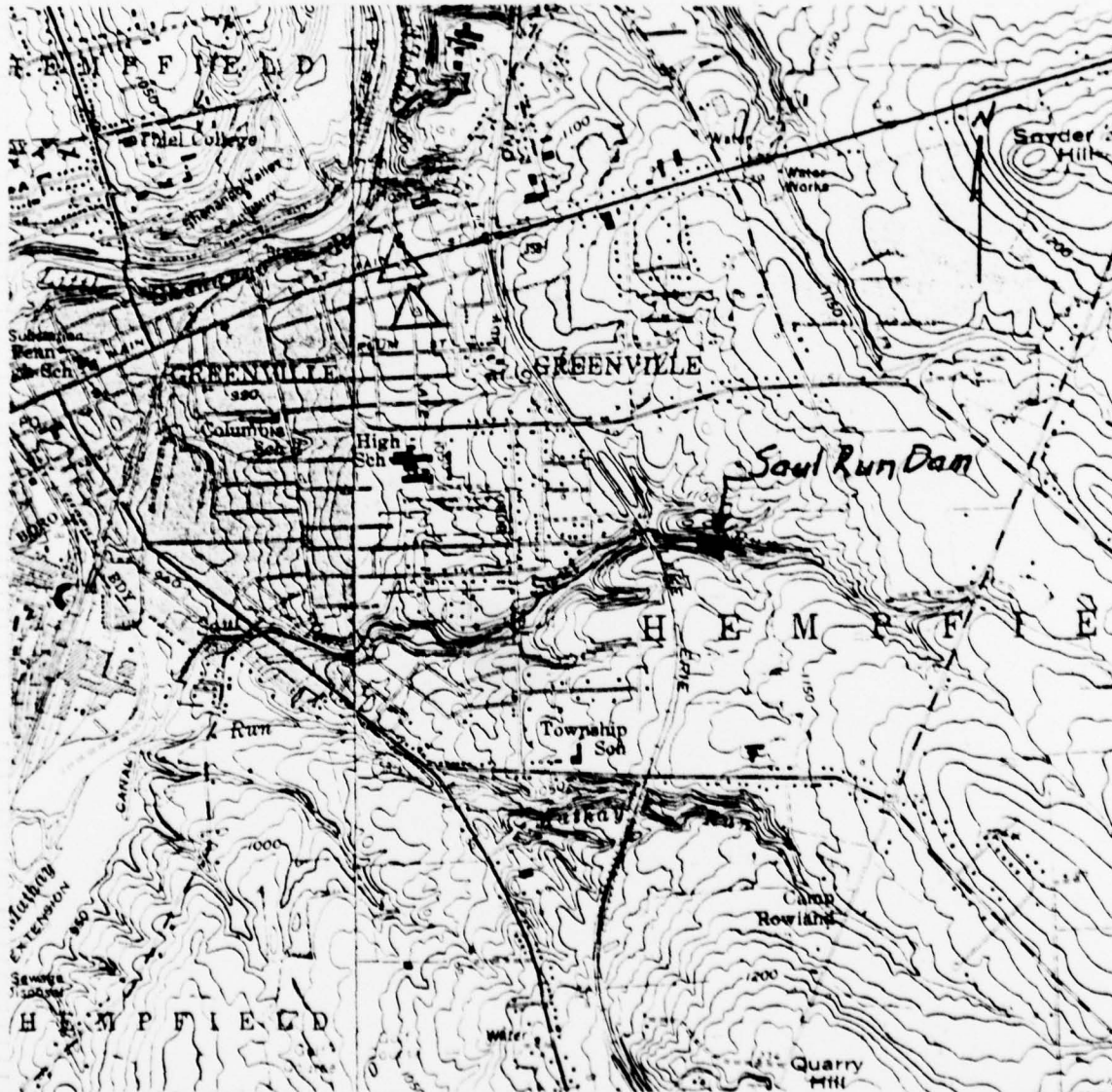
Sheet No. 5 of 10

Drawing No. \_\_\_\_\_

Computed by REH

Checked by g.a.s.

Date 3-6-79



SCALE: 1" = 2000'



\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 25 SEP 78  
 \*\*\*\*\*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A1	NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS																											
A2	HYDROLOGIC AND HYDRAULIC ANALYSIS OF SAUL RUN DAM MBJ 14																											
A3	PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD																											
B	300	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
B1	5																											
J	1	3	1																									
J1	1.0	0.75	0.50																									
K	0	1																										
K1																												
M	1																											
P	1	23.1	117	127	141	151																						
T																												
W	3.41	0.40																										
X	-1.5	-0.05	2.0																									
K	1	DAM																										
K1																												
Y																												
Y1	1																											
Y4	1086	1088	1090	1095	1100	1105	1107	1108	1109	1110																		
Y4	1111	1112	1113	1114	60	62	64	65	315	750																		
Y5	0	25	52	57	60	62	64	65	315	750																		
Y5	1425	2250	3250	4400	65	127.5	167	187.5	209	232.5																		
S5	0	3.5	12	30	65	127.5	167	187.5	209	232.5																		
S5	256.2	281	305	330	65	127.5	167	187.5	209	232.5																		
S5	1086	1088	1090	1095	1100	1105	1107	1108	1109	1110																		
S5	1111	1112	1113	1114	1100	1105	1107	1108	1109	1110																		
S5	1086.0																											
S5	1114.0	2.65	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5																		
K																												

THIS IS A ROUTING AT SAUL RUN DAM

\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 25 SEP 78  
 \*\*\*\*\*

RUN DATE 02/22/79  
 TIME 13.36

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS  
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF SAUL RUN DAM MBJ 14  
 PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

MQ MHR MNIN IDAY IMR IMIN METRC IPLT IPRT NSTAN  
 300 0 20 JOPER NWT LRPT TRACE  
 5 0 0 0

JOB SPECIFICATION

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 3 LRATIO= 1

RTIOS= 1.00 0.75 0.50

\*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

SNYDER HYDROGRAPH

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO  
 1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA

IHYDG IUNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LCCAL  
 1 1 0.97 0.0 0.97 0.0 0.0 0.0 0 0 0

PRECIP DATA

SPFE PMS R6 R12 R24 R48 R72 R96  
 0.0 23.10 117.00 127.00 141.00 151.00 0.0 0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LCSS DATA

LRPT STRKR DLTGR RTIOL ERAIN STRKS RTIOK STATL CNSTL ALSHX RTIMP  
 0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA

TP= 3.41 CP=0.40 NTA= 0

RECESSION DATA  
 STRTQM -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 3.43 HOURS, CP= 0.40 VOL= 0.99  
 2. 7. 15. 24. 35. 46. 56. 64. 70. 74.  
 75. 72. 68. 65. 61. 58. 55. 52. 50. 47.  
 45. 43. 40. 38. 36. 35. 33. 31. 30. 28.  
 27. 25. 24. 23. 22. 20. 19. 18. 17. 16.  
 15. 14. 13. 12. 11. 10. 10.



PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

RATIO 1 RATIO 2 RATIO 3  
 1.00 0.75 0.50

HYDROGRAPH AT 1 0.97 1 1377. 1032. 688.  
 ( 2.51) ( 38.98)( 29.24)( 19.49)(  
 ROUTEC TO DAM 0.97 1 1346. 576. 550.  
 ( 2.51) ( 38.11)( 27.63)( 15.57)(

Sheet 7 of 10



# SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 1086.00 0. C.	SPILLWAY CREST 1086.00 0. 0.	AVERAGE TOP OF DAM 1114.00 330. 4400.	MINIMUM TOP OF DAM 1113.6		
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX CUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1110.88	0.0	253.	1346.	0.0	43.67	0.0
0.75	1110.33	0.0	240.	976.	0.0	44.33	0.0
0.50	1109.54	0.0	222.	550.	0.0	45.67	0.0

Sheet 10 of 10

Sheet 10 of 10

APPENDIX E

REGIONAL GEOLOGY

SAUL RUN DAM  
NDI NO. PA 00251, PennDER NO. 43-48

REGIONAL GEOLOGY

Saul Run Dam is located in the northwestern glaciated portion of the Appalachian Plateaus physiographic province. Bedrock consists of flat-lying shales, siltstones, and sandstones of the Mississippian Age, Pocono Formation (Mercer County Commissioners, et al., 1960; Ellam, 1962). These rock strata are overlain by glacial soil deposits of various types and thicknesses (Shepps, et al., 1959; White, et al., 1969). Topographically, the area has broad, rolling uplands and steep sided valleys. The dam is located in a steep sided reach of Saul Run about 1 mile upstream from its confluence with the Shenango River.

Glacial soil deposits of this area are among the most complex in North America. Continental ice sheets advanced into northwestern Pennsylvania from the Lake Erie Basin at least seven times during the Pleistocene Epoch (Shepps, et al., 1959). For long intervals of time, more or less stationary ice masses produced extensive kame-type ice contact soil deposits as well as various tills, moraines, and outwash deposits (Shepps, et al., 1959; White, et al., 1969). Saul Run Dam is located in an area mapped as Kent ground moraine by Shepps, et al., 1959.

Field observations during dam inspection on 7 December 1978 confirmed the existence of ground moraine (glacial till) at the dam site but also disclosed a number of ice contact deposits (probably kames and kame terrace or kame moraine deposits) in the area east of the dam and pond. The vegetated earth channel spillway around the left (west) end of the dam was apparently excavated in dense, well graded glacial till. Shaly sandstone bedrock lies some 5 or 6 feet below the base of the spillway cut and crops out in the left (west) side of the stream channel just downstream from the dam. Material for dam construction was obtained from the spillway excavation and from borrow areas on both sides of the pond (Plate 3). Most of the borrow material appears to have been well graded, granular, and relatively impervious glacial till, though some similar kame material may have been obtained from the borrow area on the right (east) side of the pond. It seems likely that the gorge-like reach of Saul Run extending from the dam downstream to the railroad embankment (Plates 2 and 3) was an outlet for meltwater and runoff from stagnating ice blocks in the kame area east of the dam.

#### References

1. Ellam, J.J. (1962). "Dam Permit Application Report."
2. Mercer County Commissioners, et al. (1960). "Saul-Mathay Watershed Work Plan."
3. Shepps, V.C., et al. (1959). "Glacial Geology of Northwestern Pennsylvania," Bulletin G-32, Pennsylvania Geological Survey, 59 pp. + map.
4. White, G.W., et al. (1969). "Pleistocene Stratigraphy of Northwestern Pennsylvania," General Geology Report G-55, Pennsylvania Geological Survey, 88 pp.





# LEGEND

<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 20px;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">RECENT OR PRE- PLEISTOCENE</div> <div style="border-left: 1px solid black; height: 100px; margin: 0 5px;"></div> </div> <div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">ILLINOIAN OR WISCONSIN</div> <div style="border-left: 1px solid black; height: 100px; margin: 0 5px;"></div> </div> </div>	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 20px;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">PLEISTOCENE</div> <div style="border-left: 1px solid black; height: 200px; margin: 0 5px;"></div> </div> <div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">ILLINOIAN</div> <div style="border-left: 1px solid black; height: 100px; margin: 0 5px;"></div> </div> </div>	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="margin-bottom: 20px;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">WISCONSIN</div> <div style="border-left: 1px solid black; height: 100px; margin: 0 5px;"></div> </div> <div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">CARY</div> <div style="border-left: 1px solid black; height: 100px; margin: 0 5px;"></div> </div> </div>	<p>Kent Till</p>	<div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="width: 40px; height: 20px; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>Kent end moraine</b> Till (sandy loam)</p> </div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="width: 40px; height: 20px; background: radial-gradient(circle, black 1px, transparent 1px); background-size: 4px 4px; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>Findley Lake recessional moraine</b> Till (loam)</p> </div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="width: 40px; height: 20px; background: repeating-linear-gradient(-45deg, transparent, transparent 2px, black 2px, black 4px); border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>Clymer recessional moraine</b> Till (loam)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: white; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>ground moraine</b> Till (loam becoming sandy loam toward the east and south-east)</p> </div> </div>
			<p>Inner phase</p>	<div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: repeating-linear-gradient(45deg, black 1px, transparent 1px); background-size: 4px 4px; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>ground (?) moraine</b> Thin, discontinuous, weathered till blanket</p> </div> </div>
			<p>Outer phase</p>	<div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: white; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>ground moraine (?)</b> Rare patches of thin weathered till over bedrock; scattered erratics</p> </div> </div>
			<p>Undifferentiated members of units above</p>	<div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: repeating-linear-gradient(-45deg, black 1px, transparent 1px); background-size: 4px 4px; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>kames, kame terraces, kame moraines, and eskers</b> Sand and gravel</p> </div> </div>
			<p>Undifferentiated members of units above</p>	<div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: white; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>outwash (valley trains), river terraces, lake deposits including beaches of former high levels of Lake Erie</b> Bedded sand, silt, and clay; sand and gravel</p> </div> </div>
			<p>Undifferentiated</p>	<div style="display: flex; align-items: center;"> <div style="width: 40px; height: 20px; background: white; border: 1px solid black; margin-right: 10px;"></div> <div> <p><b>stream alluvium and bedrock</b></p> </div> </div>